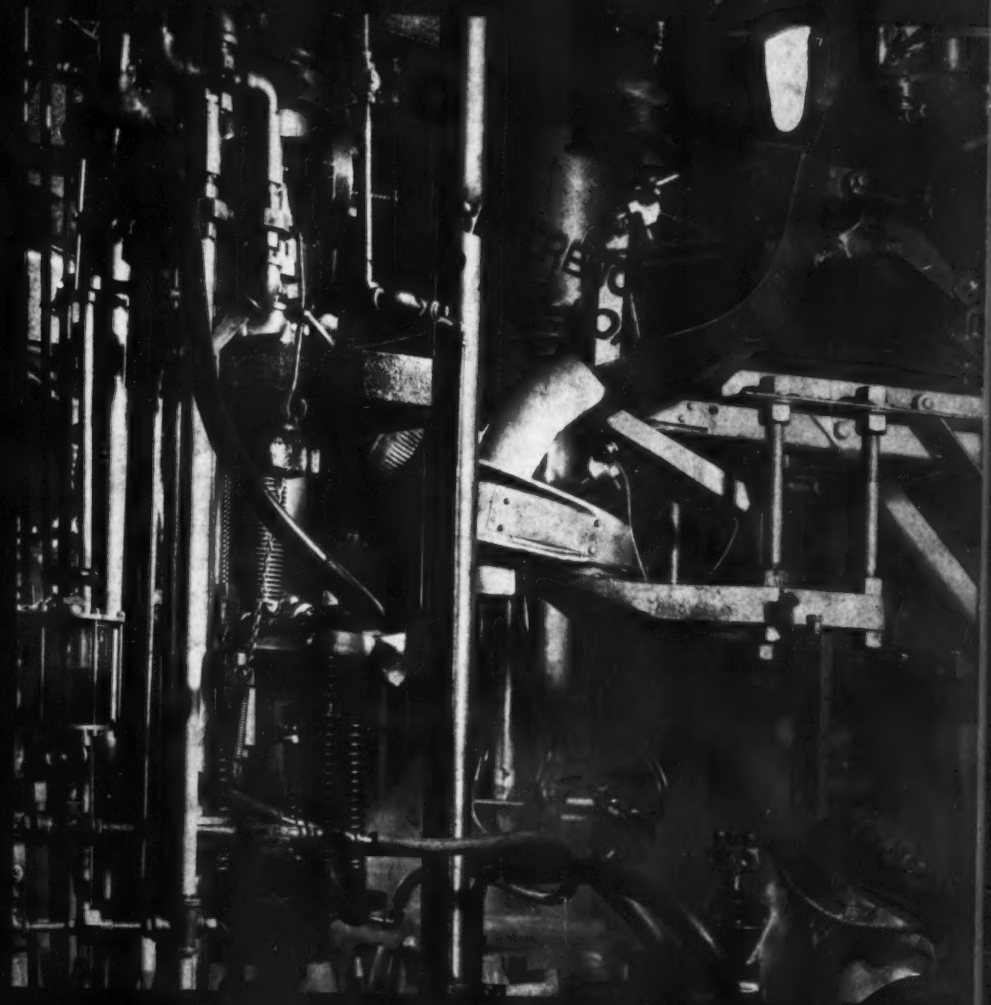
the glass industry



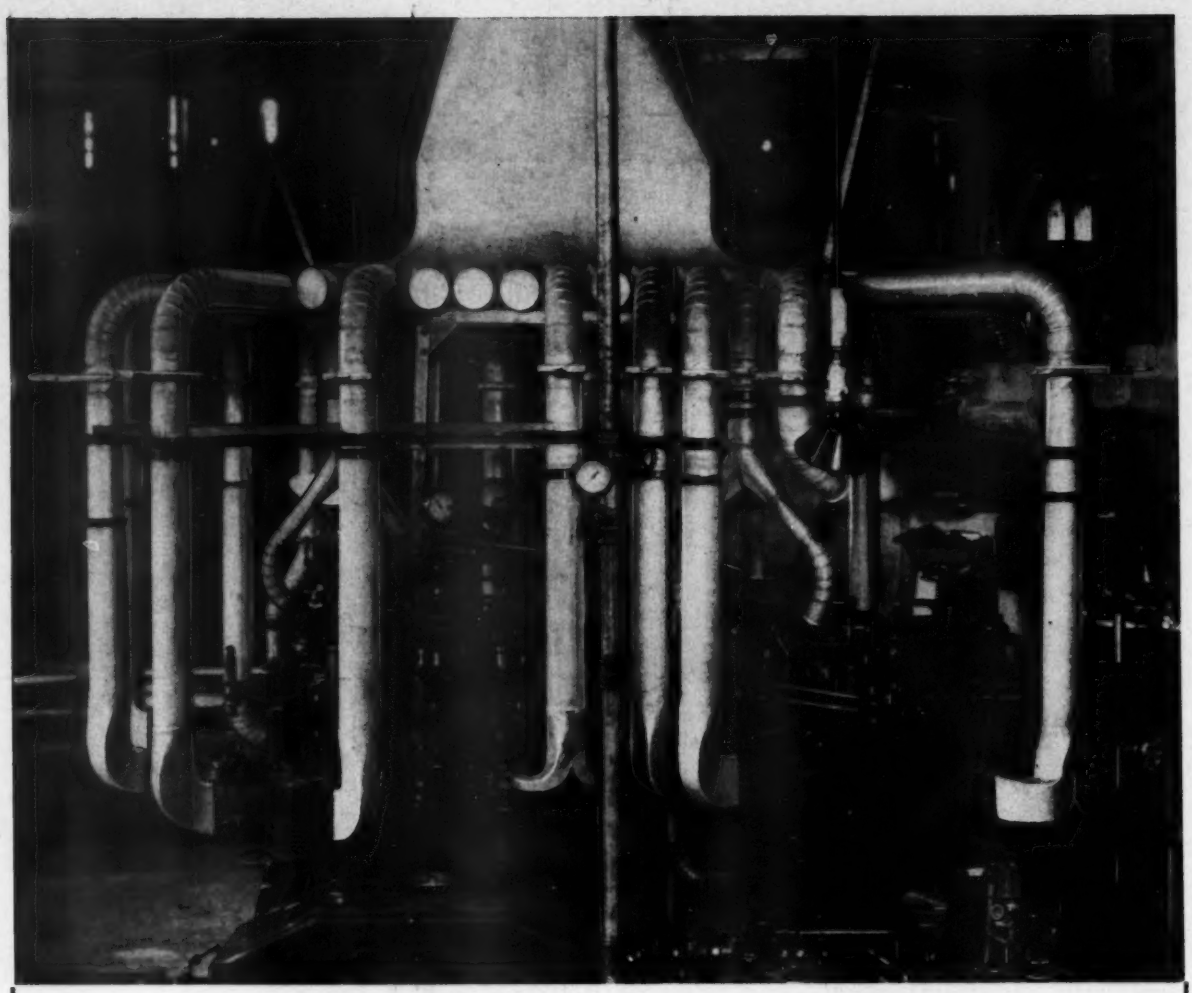


Illustration shows K & B wind system blowing cool air on the new No. 10 Lynch Bottle Machine

The Choice of Leading Glass Plants

K & B Engineers have made an exhaustive study of the proper application of wind systems for mould, conveyor and man cooling on the Lynch No. 10 and other types of bottle and Ware machines, and have developed a standard head for most of them. Why not take advantage of this experience and knowledge by requesting us to make a survey of your plant, just as we have done for the following: Ball Bros., Hazel-Atlas Glass Co., Owens-Illinois Glass Co., General Glass Co., Knox Glass Bottle Co., Fourco Glass Co., Chattanooga Glass Bottle Co., Federal Glass Co., Maryland Glass Corp., Buck Glass Co., and many others.

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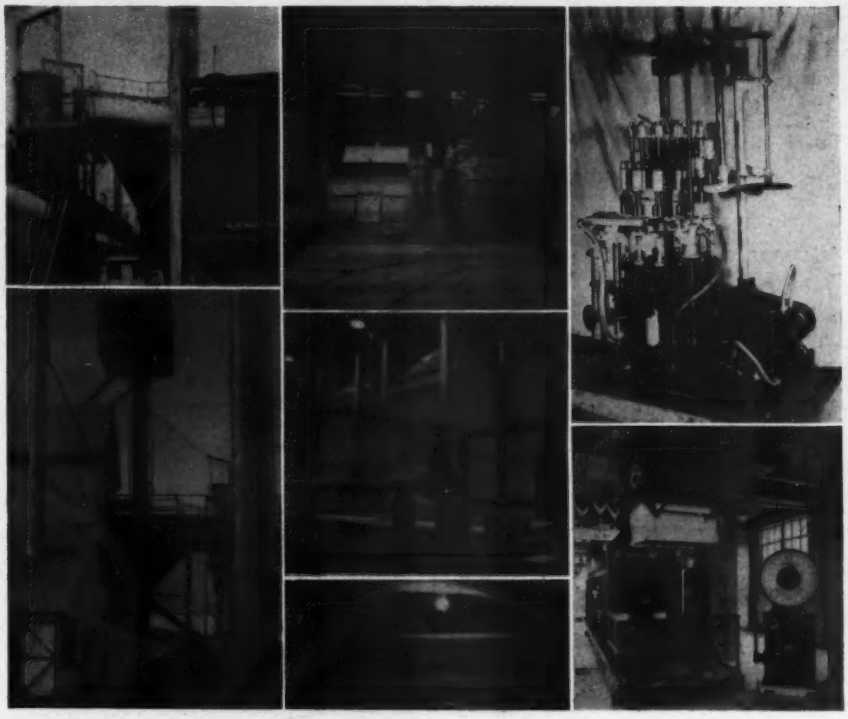

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SIMPLEX Designed Equipment

Produces Better Glass

Saves Fuel

and therefore

Makes and Keeps Many Customers

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ENGINEERS

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the glass industry

Devoted to glass technology, engineering, material and glass factory equipment and operation

PUBLISHED AT 11 WEST 42ND STREET, NEW YORK, N. Y., BY OGDEN-WATNEY PUBLISHERS, INC.

Pacific Coast Representatives: J. W. CONROW & CO., Los Angeles, California.

JOHN T. OGDEN, Editor and Publisher — CYRIL B. DELGADO, Advertising Manager

F. E. BARDROF, Associate Editor — CHARLES M. CARR, Assistant Advertising Manager

1940-1941

TP 666.1 v.21-22

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SERIAL

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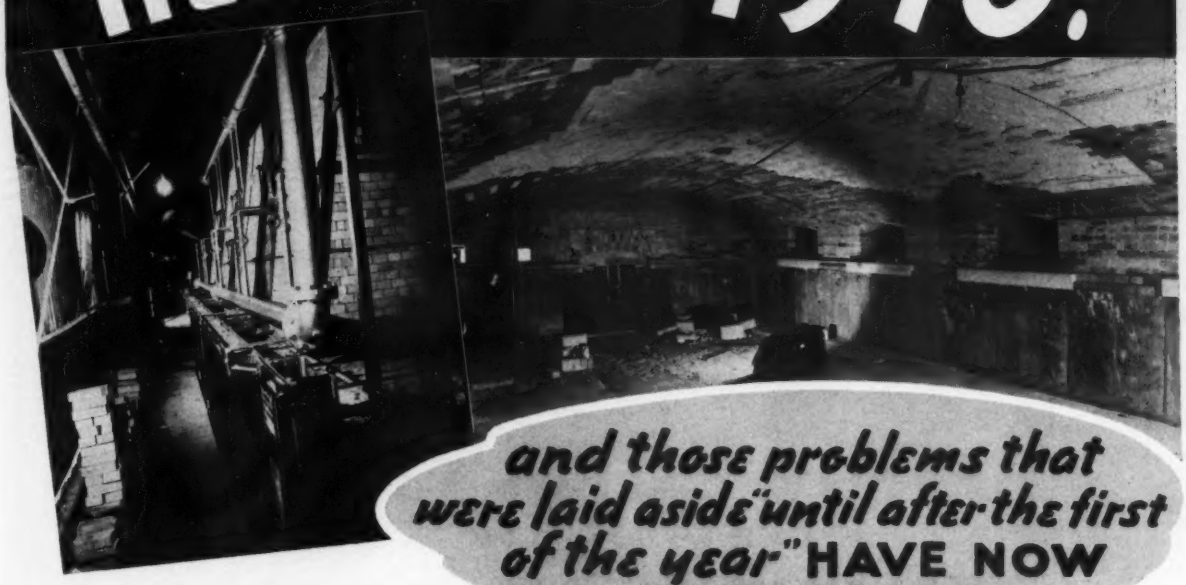
THE GLASS INDUSTRY, Vol. 21, No. 1, January, 1940. Published monthly by Ogden-Watney Publishers, Inc., at 11 West 42nd St., New York, N. Y. Subscription $3.00 a year. Foreign $4.00. Single copies, 25 cents domestic, 35 cents foreign. Issues over three months old, 50 cents. Entered as second-class matter, Aug. 10, 1921, at the Post Office at New York, N. Y., under the act of March 3, 1879.

HERE IT IS 1940!



and those problems that were laid aside "until after the first of the year" **HAVE NOW TO BE FACED**

New luminous flame tank for Lamb Glass Co. Views show fuel piping and melting chamber.

IN 1940

the matter of available fuels will be of major importance. To meet your local conditions, ask Toledo for actual operating data on dual-fuel and stand-by installations, as well as efficient furnaces for all varieties of fuel, liquid and gaseous.

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Foremost in the clamor for attention, as usual, are the furnace and combustion questions, because these are really tough and a lot of money hinges on the final decision.

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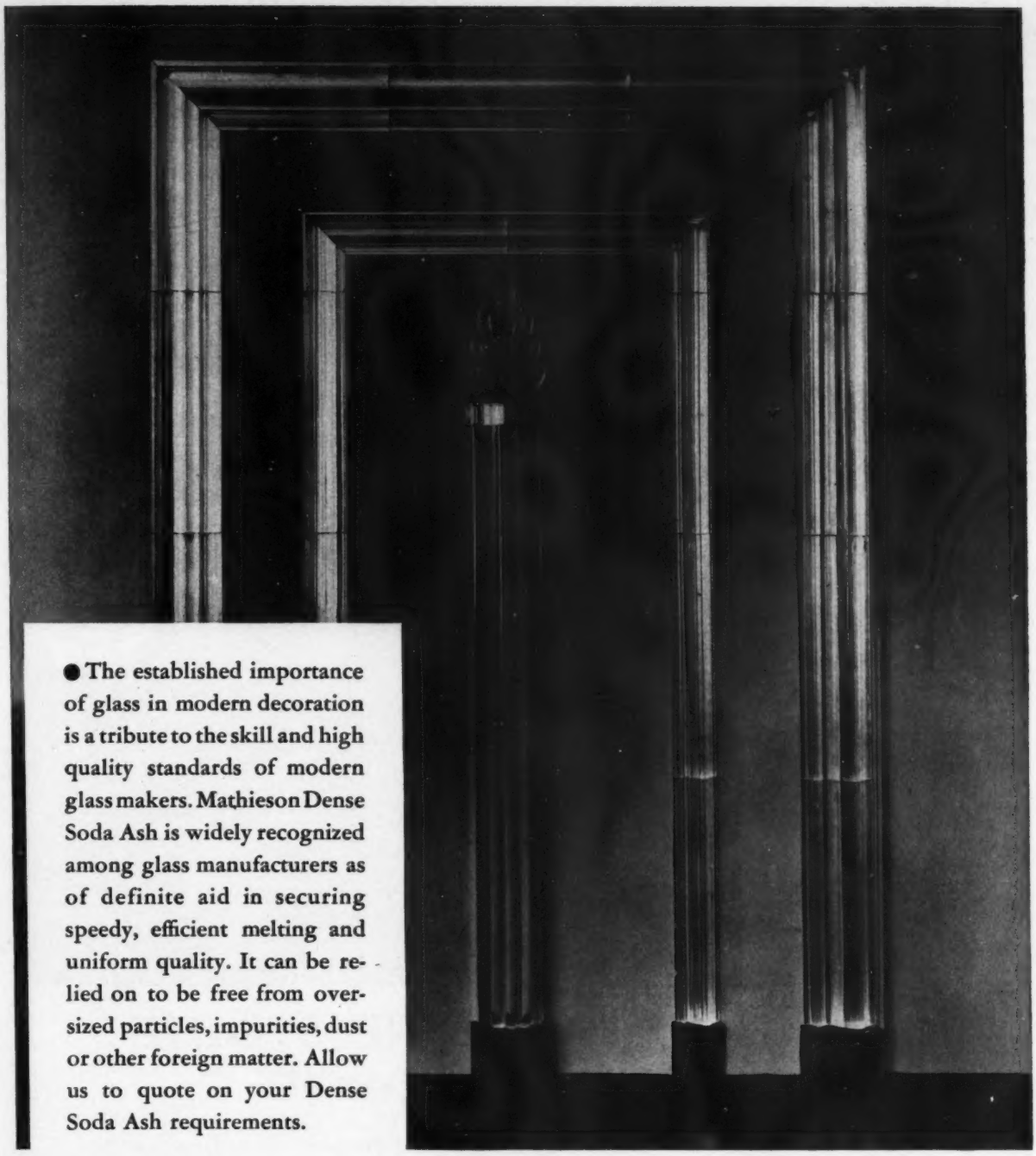

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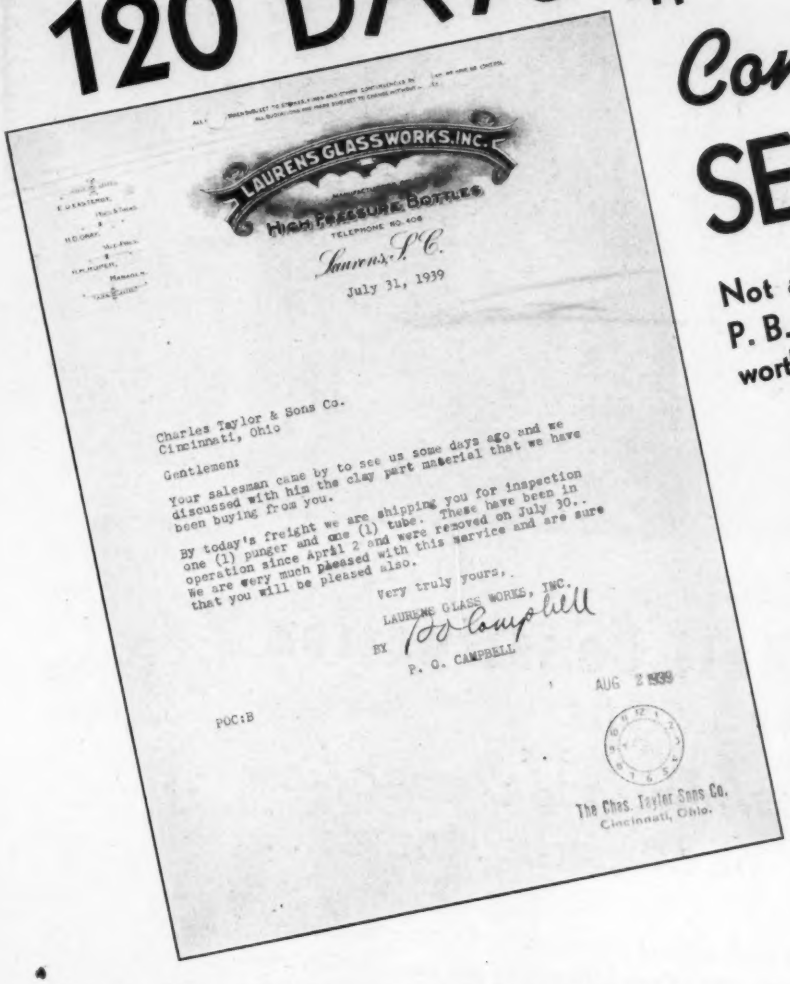

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Laurens, S. C.
July 31, 1939

Charles Taylor & Sons Co.
Cincinnati, Ohio

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Your salesman came by to see us some days ago and we discussed with him the clay part material that we have been buying from you.

By today's freight we are shipping you for inspection one (1) punger and one (1) tube. These have been in operation since April 2 and were removed on July 30.. We are very much pleased with this service and are sure that you will be pleased also.

Very truly yours,
LAURENS GLASS WORKS, INC.
BY P. O. Campbell
P. O. CAMPBELL

POC:B

AUG 2 1939
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Cincinnati, Ohio.

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CINCINNATI, OHIO

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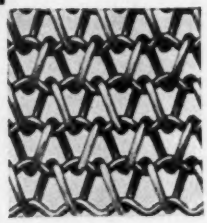
Close-up photo of Balanced Mesh Belt, showing the alternate spiral construction and crimped wire connection which assure straight travel.



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TODAY, in many plants throughout the country, Cambridge Lehr Belts are steadily building business and customer satisfaction. Here's how — Progressive dairies and bottling plants are more and more realizing that a distinctive inscription fused directly with the glass helps build business, adds to his prestige, identifies his product.

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A poker hand with three aces is good, but it takes the fourth ace to make a real winner.

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There is a similarity in the manufacture of glass. Only three ingredients, soda, lime, and silica, are actually needed to make glass, but it is that "fourth"—Borax—which makes glass better. Borax brings in the money through product improvement resulting in increased sales. Besides it saves money by reducing production costs, for Borax not only produces better glass, but its fining and fluxing properties enable melting at lower temperatures.

Borax is that valuable "fourth"—that minor constituent of major importance which helps you make better glass more economically.

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★ "The progress that American manufacturers have made in the production of quality ware at moderate prices should maintain and possibly increase the saleability of these products in foreign markets."

★ "Another development of note in the glass export trade has been the almost continuous rise in sales of tableware — largely machine-made lines."

From "*Commerce Reports*" of Aug. 26, 1939, Published by United States Bureau of Foreign and Domestic Commerce.

HARTFORD-EMPIRE inventions, developments, equipment and engineering service have long been among the most important contributions toward making this possible. . . . Its experimental glass factory, shown here, has recently been greatly enlarged and combined with new laboratories of the most modern type. • • • • •

HARTFORD-EMPIRE COMPANY

HARTFORD CONNECTICUT

THE GLASS INDUSTRY

VOLUME 21, NUMBER 1, JANUARY, 1940

THE GLASS INDUSTRY GOES ON TRIAL

Department of Justice files complaint against most of the leaders in the industry alleging conspiracy to restrain trade. Trial to be held in Toledo, perhaps in February. Civil suit is one step in a program directed against all industry under which the Administration seeks to limit "exclusive rights and privileges" clause in the Constitution.

The curtain has been raised on Act II of the Government's anti-monopoly drive, with the glass industry, as before, cast in the leading role. On December 11, a complaint was filed in the U. S. District Court, Toledo, Ohio, against 12 corporations and more than 100 individuals (some of the latter still unnamed?) alleging monopolies, attempted monopolies, combinations and conspiracies to monopolize. Most of the big container manufacturers, with Hartford, Corning, the Stevenson Corporation, the Glass Container Association, and a host of executives and officials are named as defendants in a suit brought against them by the Department of Justice.

The drama began just one year ago less a day. On December 12, 1938, the TNEC summoned the glass industry to Washington in connection with a governmental investigation into the patent laws, the purpose being to demonstrate if and how these permitted owners of patents to circumvent the Sherman Act. During the entire week of that December 12, TNEC threw its revealing spot light upon the past history of the industry, at the conclusion of which Thurman Arnold pronounced glassmen the perfect examples of how bad a group of bad boys could be, once they got their heads together.

The present suit is the outcome of those hearings. The complaint, a formidable printed pamphlet some 100 and more pages in length, parallels the TNEC transcript quite perfectly. Copies of this document appear to be secured with some difficulty, but an incomplete study of its lengthy text seems to make possible a breakdown of the allegations into three general divisions:

1. That Hartford-Empire is a patent holding company and by means of restrictive licensing has prevented free and open competition in the glass container industry.
2. That the defendant glass companies have worked hand and glove with each other, and with Hartford, to throttle competition, and to stabilize prices at a high level, and that these companies have entered into conspiracies for the deliberate purpose of restraining trade. Owens, Hazel-Atlas, and Corning in particular have entered into licensing, cross-licensing and patent transferral agreements for the express purpose of restraining free competition.
3. That the Glass Container Association, in addition to other acts, has allocated production, established quotas, examined the books and records of its members for the purpose of enforcing its quotas, and in general has "managed" the container industry.

An idea of the phraseology of the complaint may be gleaned from this single quotation, wherein it is alleged:

"The policy of Hartford and Owens, through the imposition under licensing agreements of production control and the assignment of types of ware, has maintained uniformly high, rigid, and non-competitive prices in the glass container industry. In addition, Hartford and Owens, with their complete monopoly and domination of patents on glass manufacturing machinery, have stabilized prices in the industry by requiring the leaders in the industry to establish and enforce uniform and non-competitive prices and by admonishing and coercing price cutters to maintain said prices."

An official release from the Department of Justice contains the following statement of its position with regard to patent monopoly in general. This said in part:

"The facts now in the possession of the department indicate that patent rights have been used to divide fields into non-competitive spheres, establish price-fixing schemes, divide markets into exclusive geographical areas, limit production and quality, restrict the use of products, require that outsiders purchase non-patented materials and service, enforce tying-in provisions, prevent the investment of new capital in industry, and in general to restrain trade and eliminate competition.

"In addition, it also appears that certain owners of patents, by threatening customers of alleged infringers and by concerted action in patent suits, have destroyed the markets of competitors. In some instances, notwithstanding expiration of basic patents, control and domination of an industry has continued through alleged patent improvements.

"By reason of these practices, arbitrary and artificially high and rigid prices have been and are currently being maintained in certain industries. Such non-competitive prices frequently relate to articles that are widely distributed to, and in daily use by, the purchasing public."

Whether or not the Department considers the glass industry to be one of the "certain industries," or glass containers to be among the articles "in daily use by the purchasing public" for which prices are maintained at an artificially high level, is not certain; but it surely is so by inference and by the context. By way of rebuttal, the defendants have a wealth of statistics upon which to draw if they wish, showing that prices have continuously dropped under the existing regime. But far more important than any monopoly, as a factor in controlling prices, is the competition of other container industries.

If the price of milk bottles becomes too high competitively, paper containers supplant them, as witness the upheaval in New York City only this last December. If beer bottles could be produced and sold more cheaply, surely the price would be dropped to recapture the market lost to the tin can. Indeed, in view of current events, who has the temerity to assert that glass *has* a monopoly of milk—of beer containers?

It would be difficult and unwise for any individual, no matter how well versed in the law or with the specific practices of the glass container industry, to formulate any prognostications as to the course or outcome of the forthcoming trial at Toledo. Very broad, basic principles are at issue, going far beyond the mere glass container industry and fundamental to the whole structure of all business in America. In some aspects, the present trial might be considered a test case upon the outcome of which will depend whether business or Government will manage industry. In this particular aspect, it is another one of those milestones which will show how far we have gone or are going toward a socialistic state.

The issues at the Toledo trial differ from those of former suits involving monopoly, in that they hinge on patents. In the United States, patent rights are sacred under the Constitution. This document expressly describes a patent monopoly as necessary to encourage the arts and trades: Read from Article I, Section 8:

"To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."

Acts of Congress are supposedly secondary to the Constitution and cannot contravene that fundamental bill of rights upon which all of our structure of law is founded. Hence the Sherman Act, forbidding combinations in restraint of trade, cannot override the patent monopoly privilege. The Government's own statements at the time of the TNEC hearings are significant in this connection. Government said in substance: "the patent laws *permit* what the anti-trust laws forbid."

As a matter of fact, the New Deal has no quarrel with the principle of "managed industry." Itself, it tried to bring about just such a regime under NRA. The New Deal wants managed industries—but wants Government to do the managing. It is no secret that what Thurman Arnold is after at Toledo is a consent decree. Considering the best interests of the United States as a whole, a consent decree would be most unfortunate. A consent decree establishes no fundamental principle. It would do nothing to clarify the real questions that are at issue in this trial. A consent decree would give the Attorney General's office a control of the glass industry which it could exercise in perpetuity without challenge or recourse. If that were to happen, if that precedent were to be established, then would we indeed witness the beginnings of an era of Government management of industry.

The Thurman Arnold technique is to frighten his victims just as thoroughly as he knows how, on the theory that they then will become tractable and easy to deal with. Perhaps this is the explanation of the offensive phraseology of the complaint. It bristles with allegations of deliberate intent. Acts for which there may be a perfectly reasonable explanation are referred to as studied attempts to accomplish some sinister purpose. Mr. Arnold wants his defendants to develop pronounced criminal comlpexes before they come to trial.

One interesting aspect of the present trial appears to be this: It is very much to be doubted whether any single act of any one of the defendants could be adjudged illegal restraint of trade. What the Department of Justice must have in mind, therefore, is that it can take perhaps 20 acts of the defendants, each one legal by itself, and combine them so as to produce one act that is illegal. Can this be done? Time will answer the question.

One other matter should not be overlooked; it may have a decided bearing upon the outcome. It will be remembered that at the TNEC hearings, the glass companies were given practically no opportunity to present their side. The prosecution ran the hearings, carefully avoided calling witnesses to the stand who would be in any way hostile, and maneuvered things pretty much as it wished. It is at least a reasonable supposition that the picture painted at that time might have reflected some different coloring had the defendants been allowed to defend themselves. At Toledo, the trial will be in a court of law, and we shall see what the other side has to say.

No date has been set for the trial, which will be held in Toledo. First the Government must serve each one of the defendants with copies of the complaint, and there are quite a number of the defendants. Two, incidentally, are dead. One witness is said to be in the Philippines. Each defendant must be given 20 days in which to file his answer. It has been reported that some of the defendants have already applied for an additional 20 days of grace, which it is understood the Government is not opposing. Then, however much the Department of Justice will wish to speed the trial, there will be numerous motions, presumably from each of the defendants, that have to be considered. Subpoenas must be served on witness, etc.

This calls attention to another phase that makes the trial quite unique. It is believed that this is the first time suit has been brought against an entire industry on a wholesale basis, with the acts complained of going back many years into its early history. It is difficult to believe that in a case having such important consequences, in one involving so many acts over so large a period that the court could do otherwise than act with extreme liberality toward any petitions for extensions of time.

As this issue of THE GLASS INDUSTRY goes to press, little can be stated with any authority as to what will happen next, or when it will happen. Some of the defendants, as late in the month as Christmas, stated that they did not know themselves the line their defense would take or even whom their attorneys would be. They were still studying the lengthy complaint and even then had been unable, in the short time available, to properly digest this document. Hartford-Empire makes no secret of the fact it is planning a fight to the finish. The Hartford attitude is: Certainly we have patent monopoly. So what?

In the Government's petition, no penalties are asked other than that the practices complained of be adjudged unlawful, and that the defendants be enjoined from continuing them. Dissolution of the Hartford-Empire Co. is asked, and that its patents and properties be arranged under several separate corporations, independently owned in such a way as will terminate the alleged monopoly.

STAINING GLASSES WITH SILVER: A POSSIBILITY OF STUDYING INHOMOGENITIES

By J. C. TURNBULL* and W. A. WEYL†

Among the different defects of glass occurring in the plant is devitrification and there is little difficulty in tracing its true cause and finding a remedy for it. The occurrence of gas bubbles or seeds in the ware is often more difficult to explain and the same holds true for streaks, cords and other inhomogeneities in the composition of glass.

The study of inhomogeneities in glass is greatly complicated by the fact that plant operation, as a rule, can not be studied by model operation in the laboratory. The differences in the size of batch and furnace are much too large to be compensated by simple correction factors but as a rule create entirely different conditions. The study of such inhomogeneities therefore is almost entirely restricted to careful examination of the actual plant practice and to examination of the finished ware. The great number of variables in the actual production of glass ware. such as batch composition, mixing of batch, tank design, type of refractory, firing schedule and firing atmospheres, makes it very difficult to trace any of the inhomogeneities encountered in the finished ware and examined by any of the existing methods.

In order to obtain better knowledge of glass inhomogeneities and to have better means of plant control, considerable work has been done in the study of such inhomogeneities, to classify such inhomogeneities with respect to their properties and habitus and, by careful study of the plant practice, to find whether certain types of inhomogeneities may be definitely attributed to specific steps in the production. As yet not much success has been obtained in this field of research and possibly this may be attributed partly to the fact that almost all approaches made to study inhomogeneities were made by physical (more particularly by optical) methods, rather than by chemical methods. Obviously this is due to the fact that chemical anaysis of silicates is rather involved and time-consuming. It is also by no means easy to separate the inhomogeneity from the bulk of the glass. Furthermore, such inhomogeneities, although they may differ widely in their physical and mechanical properties from the surrounding glass, often vary so little chemically from the surrounding glass that the variations may well fall within the experimental error involved in the analysis.

The present work constitutes an attempt to study one of the factors creating or accompanying certain inhomogeneities by chemical means. Many inhomogeneities in glass are caused by or involve changes in the state of oxidation or reduction in the glass, which may be primarily due to changes in the furnace atmosphere but which may also be due to many other causes, such as temperature effects and refractory attack. The present work is based on the well known fact that silver ions can be introduced into the finished glass by migration from the outside and may be precipitated in the glass under reducing conditions. This leads to the well known brownish yellow colors of silver stain. Former work, especially that of Zsigmondy[1] showed that the staining will be greatly influenced by minor ingredients or impurities in the glass such as ferrous oxide, arsenic trioxide, and sulphides. Also the alkali and more particularly the sodium content may influence the staining and it is possible that changes in alkali might also be detected by the method investigated in this work.

At present the investigations for evaluating the possibilities of silver staining for the study of inhomogeneities have only begun. It will need the cooperation of the interested industry to have the necessary amounts of material to determine the scope of this method and the variety of tasks it may accomplish. This much can be stated now, that the silver stain method will enable us to classify further the inhomogeneities observed in glass. For example it has been found that some cords detected by means of the polariscope will show up by means of the staining method while others will not. On the other hand, some cords which can not be detected with the polariscope will show up by means of the silver staining method. Furthermore, cords showing up on silver staining may appear darker or lighter than the surrounding glass. Thus it can be seen that the combination of examination with polarized light and with silver staining theoretically might allow of the following classification of cords:

1. Only visible in the polariscope.
2. Visible in the polariscope and lighter than the surrounding glass as detected by the silver staining method.
3. Visible in the polariscope and darker than the surrounding glass as detected by the silver staining method.
4. Only visible by the silver staining method and lighter than the surrounding glass.
5. Only visible by the silver staining method and darker than the surrounding glass.

It can well be assumed that in this way aluminous cords of different origin might be differentiated. The aluminous cord will be of a more reducing character than the surrounding glass in the case that refractory attack can be attributed to local strong reducing conditions. The iron present in such an impurity will be present in the form of ferrous iron to a larger extent than in the surrounding glass and thus influence the siever stain. In other cases of refractory attack, in the cord as well as in the surrounding glass, the equilibrium between ferrous and ferric iron will be about the same and the aluminous cord will not show up with the silver staining methods while it will be easily detectable by other methods.

It is impractical in this paper to give a complete survey of the different methods which have been used for studying inhomogeneities in glasses and it is still too early to discuss critically the value of the method here proposed; nonetheless an attempt will be made to demonstrate how our method supplements the others.

Inhomogeneities of the type, glass in glass, can be detected by the differences in properties between the cords

*Preston Laboratory, Butler, Penna.
†Professor of Glass Technology, Ceramics Department, The Pennsylvania State College.

or streaks and the surrounding normal glass. Perhaps most evident is the difference in the *viscosity*. This usually causes differences in the distribution of the glass resulting in a symetric shapes of the blown ware and in distorting lens effects in sheet glass. Minor deviations in the profile can be made visible for inspection by using a screen and observing the deviation in the linearity. Examples are given in Jebson-Marwedel's *Glastechnische Fabrikationsfehler* on page 32[2]. R. N. Rautian[3] has designed a special screen consisting of black and white stripes, with the black stripes three to four times wider than the white

Fig. 1. A typical pattern observed after silver staining the surface of a ring section cut from a flint bottle. The white streak is an interior cord, extending through the sidewall of the bottle.

ones. A similar grating has been used and described by E. Seddon[4]. Often it is more economical to project the shadow of the glass ware on a screen. This method is described on pages 202-206 of Jebsen-Marwedel[2].

A very similar effect occurs if the cord consists of a glass with higher or lower *refractive index*. In order to distinguish between the two cases, the glass sample has to be immersed in a liquid of the same refractive index, so that the lens and prism effects of the surface will be eliminated. For optical glasses where streaks of only slightly different optical properties have to be considered, a method was devised by Toepler in 1864. The slight changes in the refraction of the surface layer of a glass, due probably to the volatilization of alkali, have been used by K. Schröter[5] to distinguish between glass tubing made by hand operation and between the different automatic processes like Danner and Phillips. In a series of studies, W. Eitel[6] investigated the flow structure during the blowing of bottles in different processes*

As far as the strength of the glass and its resistance to thermal shock is concerned, the difference in the *expansion coefficient* is of primary importance. As a difference in the expansion coefficient results in strain which can not be removed by annealing, the polariscope can be used for detecting this kind of defect and instruments of this type are universally used in glass plants for controlling the ware. For many purposes it might be sufficient to examine the finished article for cords causing strain, but we should bear in mind that a complete picture can only be attained if the examination is extended in different directions. V. C. Swicker[7] in a recent paper pointed out the advantage of studying ring sections for the general practice of glass melting.

In some cases inhomogeneities are obscured by dense colors or opacification and only show up if the finished ware receives an acid etching. This phenomenon can be applied for studying inhomogeneities and acid etching

Fig. 2. A pattern similar to that of Fig. 1, also obtained after silver staining a ring section from a flint bottle, showing the same type of lighter inhomogeneity.

has been used for bringing out certain differences in sheet glass by F. H. Zschake[8] and tracing it in the manufacturing process.

The earlier conception that streaks might be due to difference in thermal history only has been disproved for clear glasses. Only in those cases where crystallization or immiscibility occurs, can permanent inhomogeneities be caused by differences in the heat treatment. This question has been recently discussed by N. Kreidl[9] for opal glasses and certain colors which "strike." In all other cases the annealing process will cause the disappearance of differences in the glass properties resulting from thermal history.

In colored glasses such as the manganese purple and the carbon amber we often find streaks which differ in depth of color and which are considered to be glass which is burned out. This burning out of the color consists of a *reduction* process in the case of the manganese glass and is an *oxidation* process in the case of the amber. The relationship between these streaks and the flow and molding process in making amber bottles has been pointed out by W. Eitel[6].

In ordinary glasses there are always certain compounds which are affected by oxidizing and reducing conditions and which do not show up in a visible color range as mentioned before. The only practical way to distinguish between the different areas appears to be the application of the silver staining method. As partial oxidizing or reducing influences might be the cause of

*Slight variations of the refractive index were made visible by the use of oblique illumination in the microscope. In this manner Eitel was able to analyze the flow structure of bottles made by different automatic processes.

certain defects our new method fills a definite need. Its chief advantage is that it is very specific, indicating only zones of different degree of oxidation.

Silver Staining

If the surface of a glass is painted or sprayed with a clay slip containing a silver compound (usually ochre + AgCl, 5:1) and fired in a muffle below the softening range, a part of the silver replaces the alkali and this base exchange leads to a yellowish brown glass due to colloidal silver. The same reactions occur if the glass is immersed in a bath of molten salts containing silver nitrate. Similar exchange reactions can be observed with copper compounds, here however a second firing under strong reducing conditions is required to develop the copper stain. Both methods of staining the glass can be used as tools for detecting inhomogeneities, since the speed of the base exchange; that is, the depth of color, will depend to a great extent on the composition of the base glass. However, the silver stain is particularly sensitive as an indicator of small amounts of reducing agents within the glass, whereas copper stain is affected only by strong reducing agents like iron sulphide and does not respond to arsenic trioxide or ferrous oxide. This difference in behavior can easily be explained by the fact that the silver ions, migrating into the glass, will have a strong desire to go into the metallic state and therefore will react even with weak reducing agents at the first opportunity. The more basic cupric ions need a strong reducing agent like carbon monoxide or ferrous sulphide to be converted into the neutral atoms. For this reason, the silver staining method has been chosen for the present study of inhomogeneities in glass accompanied by changes in the degree of oxidation or reduction of the minor ingredients.

The phenomenon on which our method is based has been known for a rather long time. R Zsigmondy[1] has stated that the minor ingredients, like carbonaceous residues, sulphur or ferrous oxide are of primary importance for the susceptibility of glass for the silver stain, whereas its hardness is of secondary influence. These observations have been confirmed by L. Springer[10] as well as by A. Lecrenier, P. Gilard and L. Dubrul[11, 12].

Accordingly we have to expect the development of a darker more intensive stain if the glass contains more FeO, antimony oxide or arsenic trioxide. The strongest color will be developed where such products as the sulphides of sodium or iron have been formed. Manganese does not affect the formation of metallic silver as the oxide is the stable form and possesses no reducing power except towards strong oxidizing agents, as cerium dioxide.

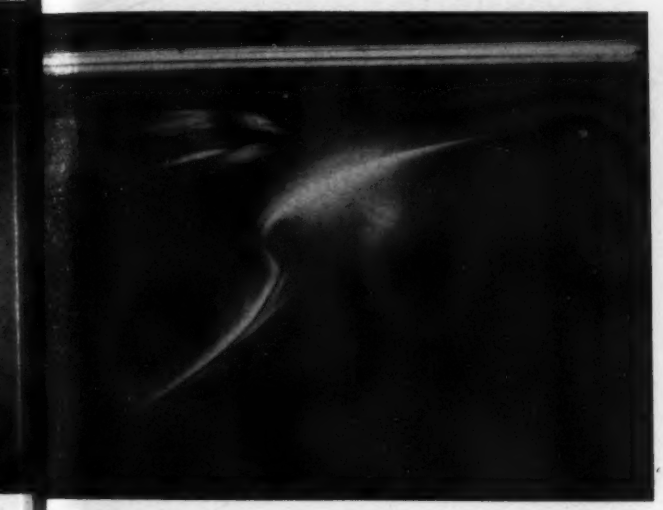

Fig. 3. Strain pattern of the ring section in Fig. 2, taken with crossed nicols. It is evident that the cord which shows as a lighter streak of glass in Fig. 2 is under a moderate strain over its entire length.

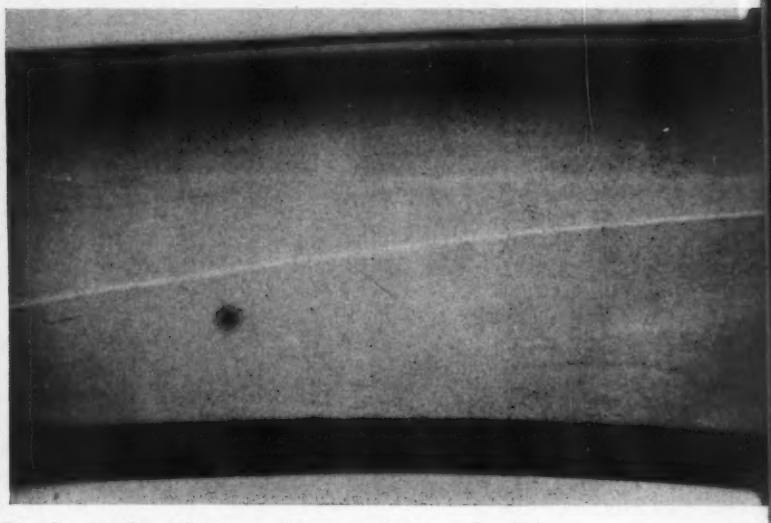

Fig. 4. Another inhomogeneity, appearing as a fine light streak after silver staining, on the surface of a ring section of a flint bottle, and similar to those in Figs. 1 and 2.

To remove defects of unknown origin it is often necessary to check the production with respect to any irregularities which might occur. If, for example, the ware shows cordiness it will be necessary to find out whether there are any irregularities in the weighing or mixing of the batch. In case the blame can not be laid to the batch plant, the cordiness will often be explained by unusual refractory attack and the whole responsibility will be shifted onto the refractory and its manufacture. The refractory often limits the possibilities of the glassmaker so far as the quality and quantity of his production is concerned, yet only a few attempts have been made to adjust melting conditions and glass composition to the peculiarities of the refractory material. This conservative attitude of the glassmelter has to be attributed, at least partly, to the lack of complete information on the reactions in the furnace. In the last few years considerable contributions to these problems have been made by Jebsen-Marwedel in his papers on "The Chemistry of the Glass Furnace."[13]

Inhomogeneities in Glass and Plant Practice

Fortunately there is scarcely a glass plant which lacks complete control of the firing conditions and in bigger plants complete records of the furnace temperature are the rule. Often however, the composition of the furnace gases and its variation with time is not fully known and little or no information is available on the oxidizing or reducing character of the different atmospheric regions

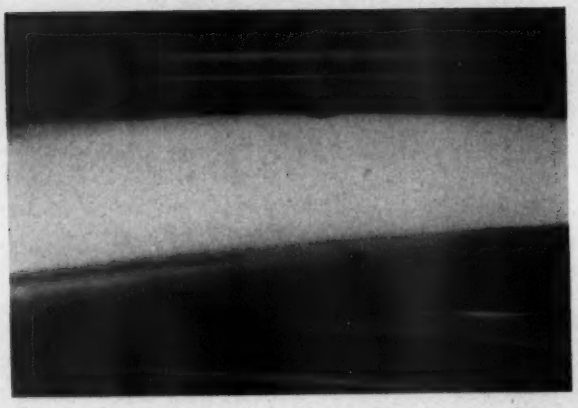

Fig. 5. Strain pattern of the ring section shown in Fig. 4, taken with crossed nicols. There is a general area of tension on one side of the light streak appearing in Fig. 4, with a general area of compression on the other side of this streak.

in the furnace. Changes in the furnace atmosphere or irregularities in the local atmospheric fields are often the true cause for certain defects. A few examples will demonstrate this relationship.

As long as we have to deal with pure soda-lime-silica glasses, there could be no obvious reason why changes in the composition of the melting atmosphere should influence the glass melting. None of the constituents can be affected by slight changes of oxidation or reduction. The minor constituents however like iron (as an impurity), arsenic, antimony and sulphate (as fining agents) are greatly affected and their reactions depend to a great extent on the composition of the melting atmosphere. Wherever color changes are produced, as in the transition of ferric oxide to ferrous oxide, or in the use of selenium or manganese as decolorizers, we notice directly the influence of the furnace gasses. These correlations are well known to the melter, but he does not often realize that very similar effects upon the melt are exerted even if color changes do not make them visible.

Local attack on the refractory wall might well be due to unfavorable distribution of the atmospheric fields within the furnace. Glasses containing saltcake as a major batch constitutent have to be melted under reducing conditions in order to help the decomposition of the sodium sulphate, which by itself would proceed only very slowly according to the reaction:

$$Na_2SO_4 = Na_2O + SO_2 + \tfrac{1}{2}\ O_2$$

If the amount of sodium sulphate in the glass exceeds its solubility limit (ca. 2%) the excess sulphate will float on the glass surface as saltwater. This liquid exerts a selective solvent power towards the glass components and withdraws CaO in particular. If by adding coal or switching over to somewhat more reducing firing conditions the saltwater is removed, an inhomogeneity may be formed which might show a tendency towards devitrification due to higher lime content.

Saltwater has also another effect which must be considered. Reaching the bridge of the tank, saltwater will give rise to severe attack on the refractory and at this stage there is little hope of reaching homogeneity again, especially as it is known that, due to the interfacial tension between the aluminous cord and the surrounding glass, this streak tends to contract instead of spreading out and disappearing by diffusion[13]. The intimate relationship between firing conditions and appearance of brushmarks with a Fourcault tank has been observed by S. S. Berman[14], who stated that these streaks wander in the rhythm of switching the regenerative system. For this reason, he was inclined to consider the inhomogeneities as "thermal streaks"; but it seems more reasonable to attribute the wandering to the corresponding change in the distribution of oxidizing and reducing atmospheric fields.

Figs. 6 to 8. Darker inhomogeneities appearing on the surfaces of ring sections of flint bottles after silver staining. These are different from the inhomogeneities shown in figures 1, 2 and 4, and consist of dark lines or areas on a generally light background.

It might be mentioned here that even in cases where the glass batch does not contain saltcake, the formation of saltwater takes place if the fuel (oil or producer gas) contains sulphur as an impurity and the melting takes place under strictly oxidizing conditions.

Under reducing conditions, i.e., when melting a carbon amber, the formation of sodium sulphate has been observed when local oxidizing areas have been formed through a leak in the wall of the glass tank. This local formation of sodium sulphate will not only give rise to the phenomena just described, but will lead to the formation of seeds of sulphur dioxide which will be carried into the finished ware. According to the equation

$$3Na_2SO_4 + Na_2S = 4\ Na_2O + 4\ SO_2$$

gaseous sulphur dioxide will be liberated at the zone where the oxidized glass containing Na_2SO_4 and the reduced amber glass containing Na_2S come in contact.

There is a particular difficulty in the removal of seeds containing sulphur dioxide as this gas can not react with the glass like carbon dioxide or water vapor except in the presence of oxygen.

These few examples might be sufficient to demonstrate how irregularities in the distribution of the atmospheric fields, heat treatment and the like may lead to difficulties in decolorizing the glass and might be responsible for a sudden tendency of certain parts to devitrification, unusual refractory attack or occurence of seeds in the ware.

Another interesting defect which hitherto was difficult to detect is the formation of iron sulphide in glasses. For example, if a glass containing iron oxide is subjected to excessive reduction, the iron oxides may be reduced to iron sulphide due to the action of sulphur derived from traces of SO_4^{--} from the batch or from the combustion gases. This iron sulphide will impart a

brownish color to the glass which is very similar to that produced by ferric oxide. Evidently silver staining provides a means of distinguishing between the color due to ferric oxide-ferrous oxide mixtures and to ferrous oxide-ferrous sulphide mixtures, since the latter will be of a much more reducing character.

It is a very difficult problem for the glass technologist to trace these common defects to their true origin. The present work is an attempt to discover the reasons of these defects in glass and to find a remedy.

Experiments with Flint Glass Bottles

The following experiments constitute some preliminary studies for the application of the silver staining method to commercial flint bottle glass. The results are by no means final and further results will be published in the future. These preliminary results, however, may serve to illustrate the possibilities of the present method and may provide some useful hints for future uses with glasses of other types and subjected to other processing methods.

All the glasses investigated up to this time were taken from bottles as prepared in actual plant practice. It will, therefore, be understood that these results apply only to glasses of a very specific type and manufacture.

In the course of this work it was found that for best results the staining should be done by means of a molten salt bath rather than by the application of a slip containing silver, the silver concentration is not as easily practice. This allows accurate control of the concentration of silver in the bath in contact with the glass; when the glass is stained by heating in contact with a slip containing silver the silver concentration is not as easily controlled. In the following work, the bath consisted of a mixture, 90 per cent sodium nitrate and 10 per cent silver nitrate, which was fused in a Pyrex beaker and heated to 800° F. At this temperature, development of color is most sensitive to the state of the glass; at lower temperatures the stain is not as stable and after it stands a while a dirty scum forms upon the surface; while at much higher temperatures the silver tends to be reduced spontaneously, giving a uniform stain under any conditions. The glass specimen was immersed in this staining bath for 30 minutes, taken out and allowed to cool and washed in nitric acid. Glass from different plants is stained to different intensities of color by the above treatment, ranging from light yellow to dark brown. This is undoubtedly connected more with the manner of melting the glass than with its composition; the amount of carbon monoxide and oxygen in the furnace controls the final state of the oxides of iron and arsenic in the case of flint glass, so that a reducing fire, for example, produces glass capable of being stained darker than that melted with more oxidizing fires.

We have been particularly interested in flint bottles made on automatic machines, and the bottles described below were all made with gob feeders. The glass was examined in ring sections made by parallel saw cuts

across the bottle, similar to those used in the polariscopic examination of bottle glass for cords. The following figures, showing inhomogeneities observed after staining with silver, are photographs of the sawed surface of ring sections taken through a low-powered microscope. Figures 1 and 2 show ring sections with a streak of lighter

Fig. 9. A pattern observed after silver staining the exterior surface of a flint bottle. These patterns usually exist only on the exterior surface of the bottle and follow the surface cords left on the gob by refractories in the feeder. Sometimes, however, they show where interior cords are outcropping on the exterior surface.

glass which extends in a folded curve through the sidewall of the bottle. This sort of streak has been found in many flint bottles, and there is often another streak opposite this one, on the other side of the ring section. This streak may occur with about the same distribution in other ring sections from the same bottle, indicating that it exists as a vertical stripe in the sidewall, parallel to the axis of the bottle. Evidently the glass in this streak is in a more oxidized state than the remaining glass, so that it stains less easily.

The origin of this oxidized streak is undoubtedly connected with that of a phenomenon sometimes observed in amber iron sulphide glass. Amber glass must be melted under reducing conditions, for otherwise the iron sulphide is oxidized and the color burned out of the glass. This happens occasionally in the feeder of a tank and a layer or fillet of white glass can then be seen floating on top of the amber glass in the feeder. The subsequent distribution and shape which this layer of glass has in a bottle may be the same as that of the white streak described above; i.e., it appears as a vertical streak, extending through the sidewall of the bottle, and often accompanied by a second streak on the opposite side of the bottle. This distribution is peculiar to bottles made with gob feeders, and we have not observed it in bottles made on suction machines.

The white streaks both in iron sulphide glass and in silver stained flint glass are obviously due to the same cause. Oxidation occurs in a layer of glass at the surface in the feeder, also the feeder fires are ordinarily run more oxidizing than the tank fires, and, since the distribution of these streaks in amber glass and in silver stained flint glass is similar, evidently the feeder or the refining end is the region of oxidation in both cases. The white streaks observed after silver staining are therefore oxidized just before the glass leaves the tank; this is substantiated to some extent by the distribution of the streaks, which are characterized by vertical lines on the sidewall of the bottle. We have tried to influence the intensity of these streaks by regulating the feeder fires; making the fires very reducing, for example, might cause the streaks to darken somewhat. However, not much variation in the fires is possible before the quality of the glass product is affected, and no detectable effect could be produced. Perhaps also the oxidizing atmosphere in the refining end of the tank is not much affected by the feeder fires.

Figure 4 shows a light streak in another flint bottle which has been subjected to silver staining. Figure 5 shows the strain pattern which is observed in this piece of glass when viewed with crossed nicols; one side of the glass is in tension and the other in compression, and the boundary between the two is just the white line observed after silver staining. If the white streak does represent the surface glass in the feeder, then that on one side of it was just below the surface in the feeder, and the glass on the other side came there during the formation of the gob. This glass has a different thermal coefficient of expansion, resulting in a permanent strain or cord. This cord has thus been caused by the mixing of glass in the feeder, and it is interesting to note that the bottle is otherwise not very cordy.

In general the white streaks are under more or less strain, although it is not often very great. In figure 3, for example, the white streak evident after silver staining (in figure 2) appears, when viewed with crossed nicols, to be strained along its entire length. In many cases, the streak is not visible before staining, either in polarized light, or non-polarized light, indicating that it is under no strain, and has the same index of refraction as the surrounding glass; in this case, the streak differs only in its state of oxidation from the other glass. Eitel[6] has suggested that, since the corresponding white streaks in amber iron sulphide glass, originally at the surface in the feeder, are pushed into the interior of the gob by the needle or plunger of the feeder, they should contain some partly dissolved viscous refractory material picked up from this member. The white streaks may therefore represent aluminous cords. However, since the surface of glass in the tank can lose sodium by diffusion into the furnace atmosphere, these streaks may also be somewhat deficient in sodium. This would affect their coefficient of thermal expansion and put the munder compression in the finished bottle.

Figures 6 to 8 are examples of inhomogeneities in flint bottle glass which after staining appear darker than the surrounding glass. These inhomogeneities probably have their origin further back in the tank than the feeder, since there is no obvious cause for them in this part of the tank. Their distribution shows this, and they are in general not at all parallel to the axis of the bottle, as are the lighter streaks; if the surface of the ring section is ground off only a few hundredths of an inch, the pattern of the dark inhomogeneities may change completely. This distribution results from the mixing to which the glass is subjected as it goes through the tank. These dark inhomogeneities are most probably caused in the melting end of the tank by local reducing atmospheric fields which exist in the furnace atmosphere; the surface glass below a strongly reducing area becomes highly reduced, and persists in this state and appears as a dark streak when the finished bottle is stained with silver. It is possible also that fluctuations in the furnace atmosphere which occur when the regenerators are changed over contribute to these inhomogeneities.

The above figures were all taken from the sawed surface of the ring sections; that is, the stained glass surface

(*Continued on page* 34)

THE STATE OF AGGREGATION IN GLASS

By RAPHAEL ED. LIESEGANG

This journal* often publishes reports of studies on the properties of glass as a solid. If, indeed, glass is to be called a solid body, the remark is in contradiction to the coined phrase that has become current among most scientists and technologists of the glass industry: "glass is an undercooled liquid," therefore no solid body. Not only for laymen is the denial of the word "solid" difficult to understand; the engineer needs it also. It is also understandable that the German Society of Glass Technology (which for a long time planned the establishment of other ideas, for example, concerning cords in glass) should express here a desire for clarification. That is all the more justified, since the terminology of individual scientists is by no means uniform, and because recently an increasing number of voices are heard disputing the idea of the liquid condition of glass at room temperature.

"Glass is an undercooled liquid." This dictum was laid down by G. Tammann[1] in 1922. In the melting process, glass has become a liquid. It is not to be denied that undercooling takes place when the melt cools down. Undercooling of a melt or over-saturation of a solution is necessary not only for glass formation, but also for crystal growth(Pure water can be brought to a temperature below -30°C. before it becomes ice. That is undercooling). But the question remains still unanswered, whether the liquid state and undercooling also exist in brittle** glass. If Tammann answers this question "yes," the answer still depends upon the conception of the solid state of aggregation. He says: "Only substances whose particles have become arranged in the form of a crystal lattice may be designated as solid." Tammann, in this remark, tacitly avoids the question of the completeness of this lattice. He can, of course, contest it for the glasses. That does not need to be proven by x-ray analysis.

The most complete lattice is presented by a "single crystal." This means that in the whole piece, the same lattice is continuous (In crystal aggregates, on the contrary, smaller lattices running in different directions are interlaced; and among the "actual crystals," which Smekal deferentiates from the "ideal crystals," gaps in the lattice, "loose places," are present or foreign matter finds its place). Now, one would expect, according to Tammann's view, that single crystals, therefore ideal crystals, would be more solid than the incomplete actual crystal, but our experience shows the contrary: an acicular single crystal of silver or copper in a thickness of 12mm. can be bent by a child into a hoop; a grown man will not be able to straighten it out again. The very destruction of the lattice has made it more "solid." Metallurgists use the expression: "solidification" by mechanical lattice distortion.—There remains to be discussed the conclusions or consequences which result for the use of the word, "solid."

How others, on various grounds, have come to a denial of Tammann's dictum must be clarified by consideration of the contributions of individual researchers.

A. Smekal might appear to follow the teaching of Tammann, if we took literally the clear statement which he expressed in a comment upon Tomaschek's[2] investigation of fluorescence: "In this sense. the glassy state, after as before, must be regarded as nothing other than an undercooled liquid."[3] But Smekal has a way out: the complete disarrangement of the molecules which we had earlier accepted as characteristic of the liquids is not present. X-ray analyses have pointed to a quesi-crystalline condition; that is, a certain amount of arrangement at least. In this, he rightly sees some reconciliation with the contrary point of view. For even in the most obvious crystals, there have been observed by some researchers some segregation or mosaic structure.

In anticipation of what is to come later, let it be said here, that at a boundary surface, the arrangement of the molecules of a liquid is often quite strongly marked. Internal boundary surfaces, however, form upon the association (aggregration, in the view of Berger) of the molecules, increasingly, as the glass cools.

E. Berger[4] says quite clearly that, "brittle glass is something other than an undercooled liquid." In addition to the solid, liquid, and gaseous, he postulates a "fourth state of aggregation," the glassy. Its place in the series (in contrast to Tomaschek) is not named. The expression, "solid," is avoided. Instead, he calls it "brittle."

Figure 1 exhibits his point of view better than a long discourse. In it, we see how separate particles begin to get large. Others remain still in the molecular size which they possessed in the melt. This existence together of the very large with the very small (polydispersion) remains to be discussed later. In the naming of the growth particles, Berger avoids the word, crystallization, because that would require that he must designate at least these portions of the glass as solid. He substitutes instead the often-used expression, "associate" crystallization. Association is also possible without crystal formation.. Association takes place also in liquids (small and large raindrops); even in gases (bubbles of varying sizes in a liquid). Aggregration is in any case the more general expression which does not exclude crystal formation, but when it comes actually to visible course crystallization, then the "devitrified" glass is indeed no longer glassy.

He used also the expressions "primary- and secondary particles." The later derive from the former by association. According to the conception of colloid chemistry, we may not designate the larger merely as secondary particles. For, even more frequently than an association, a growth of primary particles arises at the expense of those of molecular size. Thus raindrops grow to their dimensions. A running together of a number of small ones to one large one takes place only seldom, in the view of meteorologists.

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*Translated by S. R. Scholes from Glastechnische Berichte, September, 1939.

[1]G. Tammann, "Aggregatzustände," Leipzig 1922. p. 3.

**"Sprode"; this might be rendered "rigid," or "elastic." S. R. S.

[2]Glastechn. Ber. *16* 1938; p. 155-161.

[3]A. Smekal, Glastechn. Ber *16* 1938; p. 161-162.

[4]E. Berger, Glastechn. Ber. *5*, 1927/28; p. 393-405.

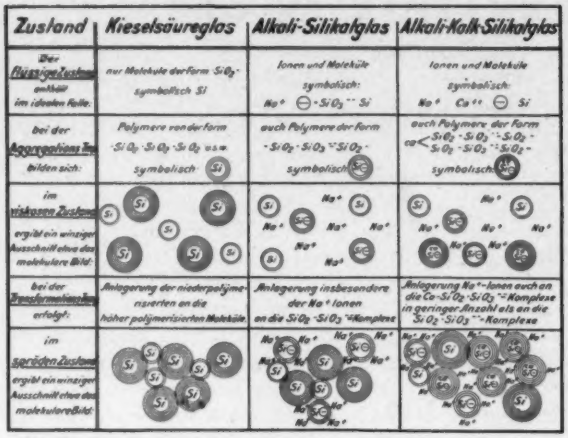

Zustand
Kieselsäureglas
Alkali-Silikatglas
Alkali-Kalk-Silikatglas
Der flüssige Zustand enthält im idealen Falle:
nur Molekule der Form SiO_2 · symbolisch Si
Ionen und Molekule symbolisch: Na^+ $\ominus$ · SiO_3^{--} · Si
Ionen und Molekule symbolisch: Na^+ Ca^{++} $\ominus$ Si
bei der Aggregation bis bilden sich:
Polymere von der Form $\cdot SiO_2 \cdot Si O_2 \cdot Si O_2$ usw. symbolisch Si
auch Polymere der Form $\cdot SiO_2 \cdot Si O_2 \cdot Si O_2 \cdot$ symbolisch
auch Polymere der Form $Si O_2 \cdot Si O_2 \cdot Si O_2$ / $Si O_2 \cdot Si O_2 \cdot Si O_2$ symbolisch
im viskosen Zustand ergibt ein winziger Ausschnitt etwa das molekulare Bild:
bei der Transformation erfolgt:
Anlagerung der niederpolymerisierten an die höher polymerisierten Molekule
Anlagerung insbesondere der Na^+ Ionen an die $Si O_2 \cdot Si O_2$ "Komplexe
Anlagerung Na^+-Ionen auch an die $Ca \cdot Si O_2 \cdot Si O_2$ "-Komplexe in geringer Anzahl als an die $Si O_2 \cdot Si O_2$ "-Komplexe
im spröden Zustand ergibt ein winziger Ausschnitt etwa das molekulare Bild:

Fig. 1. The transition of liquid into brittle glass, according to E. Berger.

Under a certain limited size, a well-stirred suspension of crystalline quartz and of amorphus quartz glass powder in a liquid, in many respects, has practically the same behavior, whether the former is regarded according to the old usage as a suspension (a solid dispersed in a liquid), the other as an emulsion (one liquid dispersed in the other). Accordingly, the fundamental distinction between amorphus and crystalline is not necessary with Berger.

The jelly theorists have it easy, when they call attention to the similarity of a silica jelly to opal, without definitely calling them the same, which state of aggregation or which mixture of states of aggregation they relate to a jelly. C. G. Bradford[5] (1919) gets away from this reservation. The formation of a jelly was to him a crystallization. This recalls strongly the foam theory for glass of Quincke[6] (1922). The notion of a (wet) sponge occurs to W. E. S. Turner[7] (1925), who otherwise agrees closely with Sosman.[8] Also H. Salmang[9] (1926 contradicts the dictum of Quincke, that the framework of the sponge can be crystalline.

If one designates amber and artificial resins as glassy, so is also a dry layer of glue glassy, and similarly, glass is colloidal; that is, in one sense of the word, similar to glue. However, no one is helped by this designation.

According to the theory announced in 1922 by R. B. Sosman, the silicon ions of the higher silica molecules are strung together like pearls on a chain. In a quartz crystal, these chains are stretched out. In the silica glass, on the other hand, they form coils. The silicate glasses are so formed that only the compounds of silica lie in the spaces between the coils of free silica; that is a special form of the sponge.

The idea of W. R. Zachariasen[10] which Tomaschek has attacked in particular, differs from the foregoing: the long chains of silica are not tangled in the silicate glass but are stretched out. They extend through the mass of disarranged silicate: a wire glass without metal wire (it may be recalled here that in biology, a threadlike structure of protoplasm is brought in, especially by von Seifriz, in explanation of its physical properties).

[5]C. G. Bradford, J. Soc. Glass Tech., *3*, 1919; p. 282-285.
[6]G. Quincke, Am. Phys. (4) *46*, 1915; p. 1025-1053.
[7]W. E. S. Turner, J. Soc. Tech. *9*, 1925; p. 147-166.
[8]R. B. Sosman, J. Franklin Inst., *194*, 1922; p. 2ff.
[9]H. Salmang, Glastechn. Ber. *4*, 1926/27; p. 172-179.
[10]W. H. Zachariasen, J. Amer. Chem. Soc., *54*, 1932; p. 3841-3851.

R. Tomaschek (1938) carried further the older fluorescence investigations of Smekal with new materials in order to come to some conclusion on the fine structure of glass. The behavior of the rare earths toward light was influenced in high degree by the state of aggregation of the (glass) mass which existed in molecular proximity. He concluded from his study (in agreement with Smekal) that there could be no crystals. He also excluded liquid. "Glass does not stand between the solid and the liquid condition, but constitutes a state of special structure which belongs in the series, solid—liquid—glassy, on the end with weaker combining power of the secondary cations." In connection with this statement of so limited a combining power of the secondary cations in the glasses, it is to be observed that Tomaschek places the light body (Europium) not in the network of Zachariasen, but in its meshes. Thus, it is well to recognize that the distance between the silica chains of the network is so great that the same effect on the light bodies would take place if the network were crystalline.

A certain unity in these postulates seems to consist in this: that in brittle glass, there is present a mixture of particles from relatively large down to molecularly small sizes. As to the shape of the former, difference of opinion still rules. The particles of molecular size permit to those of relatively large size, a certain mobility in the viscous condition. Accordingly, they operate as a lubricant.

When, in very cold weather, disturbances arise in railroad operations, they may often be traced back to a lubricating oil too sensitive to the cold. Thus, at Berger's transformation point, it may be that only the portions of molecular size suffer change. The others might, as in the railway comparison, remain unaltered.

Consideration of the distribution of particle size seems to be more important than a decision as to the state of aggregation. To quote from the dictum of Berger: "the concept of brittle glass as a two-phase heterogeneous body has a certain significance for the kinetics of processes of aggregration," The word "phase" is to be used with especial caution. In present day physics, the opinion prevails that separation into solid, fluid, or gaseous states of aggregation may be too superficial. The division will be retained only for the sake of phase-rule studies.

Accordingly, it cannot be wrong to speak of "solid glass." In doing so, we must only avoid thinking of the old expression, "solid state of aggregation."

STEUBEN PLANS NOTEWORTHY EXHIBIT

On January 10, 1940, the doors of Steuben Glass at 718 Fifth Avenue, New York, will open on an exhibition which is the culmination of three years' intensive work. Twenty-seven of the outstanding contemporary artists of America and Europe have been commissioned to make designs which Steuben has reproduced in engraved glass. Each piece is limited in production to six, one of which will be retained for the permanent Steuben collection, leaving five for disposal to museums and collectors.

The collection will be presented in the stemware room at the rear of the shop, where it will be on exhibition until February 12, unless the demand warrants holding it over for two or three weeks.

XMAS TREE BALLS BEING MADE AT CORNING

The manufacture of Christmas tree balls, long a monopoly of Bohemia, has become an American industry. Study of the problem by the Corning Glass Works has disclosed that the ribbon bulb-machine can produce these articles efficiently and economically

The manufacture of Christmas tree balls has always been a near monopoly of the Bohemian glass blowers, who made them by hand in their homes and cottages. Hand blown balls are never uniform, if for no other reason that no single family has two blowers equally skilled. Some quantities have been made in Germany, Poland and Japan. During the World War of 1914-1918, production was undertaken in the United States; but with the cessation of hostilities, the European product, made cheap labor, resumed its dominant position, and only one manufacturer in this country remained in the field. The Czechoslovakian treaty, further reducing the tariff, became effective in 1938, and that snuffed out what was left of American effort.

In 1937, imports of Christmas tree ornaments exceeded in value a million and a quarter dollars. The year following, this figure fell off to slightly over a million, though it is probable that the shrinkage was in value only, not in volume, resulting from the lower tariff.

Midway in 1939, however, it became apparent that a continuance of the war would deprive the American public of its supply. The buying season is in the spring of the year. And while domestic production would not be an important factor in 1939 business; yet, orders already placed could not be delivered in their entirety. As for 1940 business, it seemed no source of supply could be found.

Corning immediately tackled the problem with its ribbon machine. In September, its first samples were approved. By November, the first shipments were made, and more than a million were sold and shipped before Christmas.

Because of the machine method of production, the domestic ornament differs from and is superior to the imported hand made article in three particulars: It is absolutely spherical, and hence stronger. The long, slender neck has been shortened and made larger. This also makes the article less fragile. Thirdly, the metal caps are fastened on a great deal more securely, whereas the imported article habitually falls apart or breaks, even while being put on the tree.

The Corning method of manufacturing Christmas tree ornaments follows pretty much the process of lamp manufacture. An additional step is the decorating. A silvering solution is poured into the bulb, after which the bulb is placed on a rack and shaken. The shaking allows the silvering solution to cover completely the inside of each bulb. Next the bulbs are emptied and immersed in colored lacquer, after which the lacquer is fired to the outside.

Corning's new ornaments are furnished in five different colors and in two sizes. The two-inch size weighs approximately eight grams and the three-inch size 12 grams. In thickness they are about the same as the imported article, although they contain more glass.

Foreign hand-blown balls (see model's left hand) differ in appearance from the American machine made article in that the former has a larger and more fragile neck, to which the metal suspension cap is less securely fastened.

PELTIER DEFENDS MARBLE MAKING PATENTS

The Peltier Glass Co., Ottawa, Ill., has sought to enjoin the Johnson Glass Co., Chicago, and the R. B. Burns Machinery Co., Ottawa, from making use of its secret process for making marbles. Peltier claims that it had instructed one of its employees, Charles Day, in the process as necessary to the latter's performance of his duties. Day subsequently entered the employ of the Johnson Company, and according to the bill of complaint, the Burns Company is now building the plaintiff's marble making machine for Johnson.

Dominion Glass Company, Ltd., reports a profit of $595,422 for the fiscal year ending September 30, which compares with $532,579 earned the preceding year. T. W. Bassett, general manager, was elected vice-president as well as a member of the Board of Directors. Another new member of the Board is F. G. Bush, of Montreal.

The amusement game industry consumed 3,000,000 sq. ft. of sheet glass in 1935, according to Coin Machine Industries, Inc., the trade association of that industry. Figures since 1935 are not available, but the yearly production of games has increased steadily since then.

● WANTED—Position in Glass Plant Supervision or in Laboratory by young man with five years plant experience following graduation as glass technologist. Experience in glassmaking, analyses, and furnace operation and maintenance. Excellent references. Go anywhere. Box 34, The Glass Industry.

GRECIAN GLASS: A MODERNIZED ANTIQUE

By ALEXANDER SILVERMAN
Department of Chemistry, University of Pittsburgh

A few weeks ago the writer wandered into a building in the New York World's Fair which bore the inscription "Kingdom of Greece." Here was a revelation in the application of ancient designs to modern art in pottery and glass. The story follows.

Thirty years ago there was organized in Athens, Greece, the Societé Anonyme Hellenique de Produits et Engrais Chimiques for the production of acids and other chemicals, fertilizers, medicinals and germicides, glass bricks and roofing, plate glass, and clay products and refractories. Today this organization is the largest company in the Balkans and near East, a billion dollar corporation with seven thousand employees and over a thousand professional men, such as engineers, mineralogists, chemists, artists, etc. The Director of the corporation is the eminent Greek scientist Spiros Vretos.

The writer will confine himself to the antique glass which is on exhibition in New York. Its production started as an advertising venture and has become one of the most important interests of the Societé. In the beginning there was merely an endeavor to show the world what could be done with glass in Greece and to tie this experimental venture up with the Societé for advertising purposes. At first the Company employed artists from all Europe and had them design plates and vases which would appear to advantage in glass. The artists employed the designs of their own nations with which they were most familiar; namely, the Italian Muranese, French Lalique type, and others. It then occurred to the officials that a typically Greek art might be developed which would more characteristically publicize the Company's work. Artists, students of Grecian art, were next engaged. They were commissioned to head up a new division.

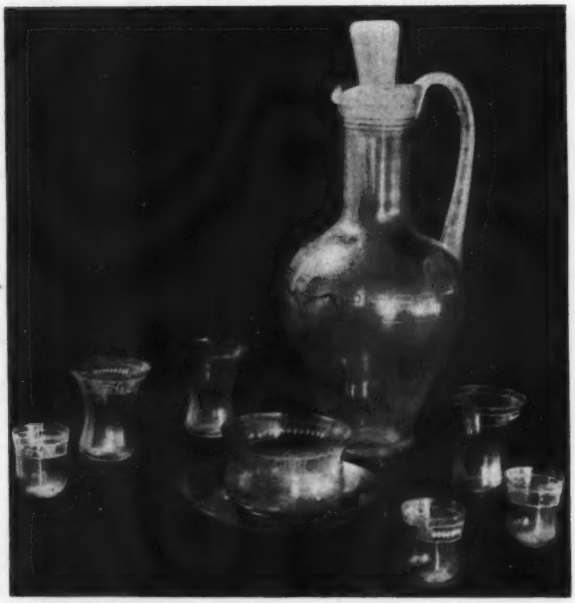
The Company's chemists produced a novel glass which could be used for antique effects. It is much like any other glass which is incompletely melted, but it has a few characteristics, namely, a milky green color and a faint iridescence. It also possesses an unusually rough texture and looks as if it had been buried for centuries. It is said that the Greek soil contains certain chemicals in specially selected deposits which produce this unique effect and that after acid treatment an article results which it would be difficult for other nations to reproduce. Among the many professional artists in the Antique Division are the well-known Grecian women Katherine Petria and Despo Paraskevaidou.

In the writer's estimation, the real motivating spirit in this antique glass venture is Alexander Kitanidis, an interior decorator, who is a graduate of the Beaux Arts Institute of Athens. This attractive, tall, broadly informed gentleman is saturated with ideas and bubbling over with enthusiasm. He has represented the Societé and the Kingdom at expositions in Berlin, Smyrna, Constantinople, Paris, etc., and has studied foreign art extensively.

He is the special delegate from the Societé Anonyme to the New York World's Fair. His enthusiasm is contagious. Any visitor who has the good fortune to meet Mr. Kitanidis gets an appreciation of modern Grecian art. Unfortunately, the political situation in Europe made his return to Greece imperative and he sailed on September 27 on the S. S. Nea Hellas. During his brief stay in America he served as honorary consultant on art to a number of large establishments, such as Radio City Music Hall. He has left us with a growing interest in the modern concepts of ancient design in art glass, numerous examples of which have already been acquired by private collectors and by art curators in America.

The Societé Anonyme Hellenique follows an admirable policy in the production of its art. It never duplicates a design. Each piece is unique. The modern Grecian artist has placed his own aesthetic signature on the work. He has viewed what the ancients left and made the design the more attractive in the light of modern creative thought.

Winding or geometrical designs provide a border, mottled or antique glass is the background, and etched silhouettes in black and colors of charioteers, javelin throwers, the hunt, animals in flight, and, more reverently, the ancient dieties, afford a compelling motif. The illustrations which accompany this article indicate a few of the many shapes and designs which have already fascinated America. A real appreciation comes only through seeing the originals.



*Contribution No. 393 from the Department of Chemistry, University of Pittsburgh. The cooperation of Miss Roxane Cotsakis is gratefully acknowledged.

EFFECT OF SULPHUR GASES ON SURFACES (A REVIEW)

Back in the days of the open-fired type annealing lehr, one of the most common "lehring" defects was that of lehr bloom. This defect was so commonplace that the presence of this bluish-white film on the glass surfaces after annealing came to be considered by some as an indication of proper annealing conditions and was often used as a measure of the quality of annealing. Others, however, considered that the only value of lehr bloom was that of a nuisance value, inasmuch as its presence gave the glass a dirty appearance and a greasy feel, making it necessary to wipe or wash the film from the glass surface before it could be packed for shipment.

It was well known to the old glassmakers that the cause of lehr bloom was due to some sort of a chemical reaction taking place between the basic constituents of the glass and the acid gases present in the products of combustion when the later came into contact with the glass during the annealing period. In fact, E. Siegwart[1] as far back as 1872 stated that the action of the gases in the annealing furnace produces a white film of sodium sulphate by action on the alkali of the glass. As evidence of this reaction he also quotes an experiment in which a bloomed piece of glass 2,000 sq. ft. in area gave up 27.3 grams of sodium sulphate when it was washed with water. Bielby[2] while investigating the action of certain gases on glass in the neighborhood of heated metals conducted some experiments with gases and glass in the temperature range of 500 to 600° C. He found that air containing a high proportion of SO_2 and moisture produced a white film on all parts of the glass exposed to the gases. With sulphuric acid vapors the attack was very distinct from which fact he concluded that it was the sulphur trioxide radical that was responsible for the white film found on glasses heated in gas furnaces or muffles above a certain temperature. It was further explained that the formation of sulphur trioxide was due to the presence of hot metal throwing off ions which played the part of nuclei, while in the case of the products of combustion these seemed to carry with them sufficient nuclei to guarantee the formation of the trioxide.

While there are many other references in the literature regarding the cause of lehr bloom, the following more modern researches will suffice to show that it is a well established fact that acidic gasses, especially sulphurous gases, and the alkali of the glass will react chemically at temperatures such as are found in the annealing range with the formation of soluble alkaline salts.

Guss[3] states that lehr bloom involved the formation of sulphates or sulphites which are produced through the action of the sulphur dioxide contained in the products of combustion on the alkali of the glass and that this filming did not occur with electric annealing, annealing with natural gas or with annealing carried out in a neutral atmosphere. He also stated that with repeated annealing of the glass, the amount of fresh deposit always became less and less indicating that as a result of sulphuring a reduction of alkali took place at the glass surface. Zschacke[4] also pointed out that bloom was due to the action of the products of combustion on the alkali in the glass and that it occurred more often in a strongly oxidizing atmosphere. This latter observation led him to conclude that the sulphur dioxide present must be oxidized to sulphur trioxide. According to Zschacke, soft glasses showed greater amounts of bloom than glasses of higher chemical resistance. In addition, he also stated that the carbon dioxide and water present in the products of combustion played a distinct part in these chemical changes.

From the above observations on the cause of lehr bloom, it is obvious that with the advent and general use of the newer types of lehrs in which the products of combustion no longer came into contact with the glass surface, the lehr bloom defect would disappear. However, with the replacement of the open-fired type lehr and the adoption of better firing conditions in those cases where the open-fired lehr was used, both the glass manufacturer and the glass consumer began to notice differences in the performance of the glass during use. For example: bottles which had been made from the same glass composition but which had been annealed in the muffle type lehr instead of the open-fired type lehr did not show as good a chemical resistance as formerly. Likewise certain mechanical properties such as thermal shock resistance were adversely effected. Such differences naturally led various workers to investigate the problem with the result that it was found that regardless of the merits or demerits of lehr bloom as far as an annealing guide was concerned, the blooming of the glass in the lehr definitely improved the chemical resistance and certain mechanical properties of the glass.

It is interesting to note that the beneficial effect of annealing glass in the presence of sulphurous gases on the chemical resistance of the glass was known and announced as far back as 1910. In a report of the National Physical Laboratory,[5] it was stated that a special feature of the "new" (1910) Jena chemical glassware was its increased resistance to the attack of chemical agents, this increased resistance being obtained by annealing in the presence of sulphurous gases.

This early work of Schott and Gen. was confirmed by Keppler[6] in a discussion on methods of testing chemical resistance of glass. Keppler stated that during the slow annealing process a concentration of alkali takes place at the glass surfaces and that the acid constituents, CO_2 and SO_2 of the flame gases neutralized and removed this alkali, hence the flame gases during annealing exerted a decidedly improving effect on the surface of the glass. Keppler[7] also investigated the effect of carbon dioxide and water during the annealing process. In his experiments, water saturated carbon dioxide was passed into a flask during annealing (400° C). After this treatment the chemical resistance of the interior glass surface was found to be very high due to the removal of the surface alkali through the formation of lehr bloom. Ueda[8] treated a soda-lime silica glass at 600° C for specified times with various acid gases and vapors. Dimming (weathering tests, moist air at 60° C) tests made on both the treated and untreated glasses showed that the treatment with acidic reagents rendered the glass more resistant to dimmings. Kamita[9] in his patent claims, describes this method of test as follows: treated and untreated pieces of clean glass were placed in an

enclosed vessel which was saturated with moisture at the temperature of 60° C and left until weathering took place. The degree of weathering was tested by the Mylius' iodine eosine method and the eosine value was calculated to milligrams per square meter. Typical results obtained are given in Table I.

TABLE I	*Days Given for Weathering*	*Eosine Value*
Glass A		
No Treatment	8	65.9
Treated	8	0
Glass B		
No Treatment	6	300.0
Treated	7	0
Glass C		
No Treatment	3	400.0
Treated	7	0

A direct comparison of the effect of the type of lehr on the durability of glass annealed therein has been made by Cousen[10] during an examination of a standard test for the chemical durability of glass bottles. Cousen's results showed that a wide-mouthed bottle annealed in the open-fired lehr has a greater chemical resistance than a similar bottle annealed in a muffle type lehr. This was not true in the case of narrow neck bottles. It was concluded that the acidic gas fumes in the open-fired lehr neutralized the surface alkali of the bottle, but these gases are only effective when the neck of the bottle is wide enough to admit of an easy inflow of the fumes. Typical results as obtained by Cousen are given in Table II. Peddle[11] from the results of a very comprehensive study of the performance of the two types of lehrs reached the same conclusions in regards to the effect of sulphur containing gases as did Cousen.

TABLE II

Type of Bottle	*Type of Mouth*	*Type of Lehr*	*Attack in Mg. Per Sq. Dm.*
10 oz. Pickle	Wide	Muffle	1.90
10 oz. Pickle	Wide	Open	0.57
6 oz. Pickle	Wide	Muffle	2.14
8 oz. Milk	Wide	Open	0.53

In recent years several patents have been issued covering various methods for artificially blooming the surface of glass, particularly the interior surfaces of glass containers, in an effort to improve the chemical resistance of the glass. German Patent No. 512,904, March 3, 1927, issued to G. Keppler, covers the introduction of substances capable of developing gases that react with alkali on heating into the already formed hollow-ware. K. Kamita, in U. S. Patent No. 1,782,169, Nov. 18, 1930, deals with a process for preventing the weathering, clouding and tarnishing of the surface of glass. The process consists of treating the surface of the glass with an acidic gas at a temperature between 300° C and 600° C. The acid gas being a mixture of gas normally present in the lehr and additional acid gases such as sulphur dioxide, hydrogen sulphide, selenium oxide gas, chlorine gas, hydrochloric acid gas, bromine gas, nitrous oxide gas, nitric acid gas and carbon dioxide gas. U. S. Patent No. 2,046,302, June 30, 1936, issued to U. E. Bowes describes a method and apparatus for feeding pellets which when dropped into the already formed hollow-ware are fired by the heat of the article and create acidic gases which neutralize the alkalinity of the interior of the ware. A. E. Lauck and J. M. Johnson, U. S. Patent No. 2,109,391, Feb. 22, 1938, also describes apparatus for the feeding of such pellets. In U. S. Patent No. 2,154,490, April 18, 1939, issued to O. G. Burch, the process of blooming is carried out at the forming machine. Acidic gases such as sulphur dioxide, hydrochloric acid gas, carbon dioxide gas or mixtures thereof are passed to the blowhead and so to the interior of the just formed container.

Turning to the effect of bloom on the strength of glass Murgatroyd and Wardley[12] developed a method whereby sulphur or any other medium capable of attacking the glass surface could be introduced into the lehr, reacting with the glass surface during the annealing period thereby increasing the resistance of the glass to thermal or mechanical shocks through the rounding-off or filling-in of the minutes discontinuities or flaws which occur in the surface of the glass. Experiments by Murgatroyd[13] on the effect on the mechanical properties of glass of this artificial blooming showed that there was a substantial difference in strength between ware annealed in an ordinary muffle lehr and ware annealed in the presence of sulphurous gases and stated that the thermal endurance of glass containers could be raised by 12 to 14 per cent, the bursting pressure by 15 to 20 per cent and the impact strength by 15 per cent by annealing in the latter manner. Typical data are given in Table III.

TABLE III	Annealed in	
	Ordinary Muffle	*Presence of Sulphurous Gases*
Av. Breaking Temperature	70°C	82°C
Av. Bursting Pressure lbs./sq. in.	370	404
Breakage on Standard Impact Test	85%	45%

Peddle[11] in his comparison of the performance of various types of lehrs proved conclusively that both natural sulphuring such as is encountered in the open-fired lehr and artificial sulphuring carried out by introducing sulphur dioxide into the muffle lehr materially improves such mechanical properties of the glass as impact resistance, thermal shock resistance and internal pressure resistance. The increase in strength obtained by natural sulphuring was found to be much greater than the increase in strength obtained when artificial sulphuring methods were used.

While the benefits of bloom, whether natural or artificial, are now well known and the chemistry of the reaction is fairly well understood, recent papers[15] [16] from the Society of Glass Technology indicate that the subject is still of theoretical interest. A more complete understanding of the theoretical aspects of the effect of sulphurous gases on glass surfaces might bear fruit in the development of a procedure that has all the advantages of the present lehr bloom without its apparent disadvantages.

[1]Dingler's Polytech Journal, 1872, 205,21
[2]G. T. Beilby, Chem. News, 1904, 90,180
[3]Glashutte, 1930, 60,935 and 954; 1931, 61,8
[4]Glashutte, 1930, 60,791
[5]J. Soc. Chem. Ind., 1915, 34, 210
[6]G. Keppler, Glastech. Ber. 1927, 3, 97
[7]Sprechsaal, 1928, 61, 300
[8]Rep. Asaki Glass Co., Res. Lab. 1927, 17, 391, also J. Soc. Chem. Ind., 1929, 48, 95B
[9]K. Kamita, U. S. Patent No. 1,782,169, Nov. 18, 1930
[10]A Cousen, J. Soc. Glass Tech., 1936, 20, 418
[11]C. J. Peddle, J. Soc. Glass Tech. 1937, 21, 177
[12]J. B. Murgatroyd and T. Wardley, British Patent No. 369, 900, Sept. 25, 1930
[13]J. M. Murgatroyd, J. Soc. Glass Tech., 1933, 17, 260
[14]J. B. Murgatroyd, Glass, 1931, 8, 272
[15]J. N. Coward and W. E. S. Turner, J. Soc. Glass Tech., 1938, 22, 309
[16]J. Boowand, W. E. S. Turner, J. Soc. Glass Tech., 1938, 22, 357

THE GLASS INDUSTRY IN NOVEMBER

NOVEMBER witnessed a continuance of the high rate of activity under which the glass industry has been operating throughout the fall. Production fell off only slightly, with all factories maintaining a faster pace than is normal with them at this season of the year. Payrolls maintained the October level, and employment actually increased. Exports held up well despite the records set in recent months and imports picked up considerably, without however attaining last year's volume.

According to Glass Industry's Production Index glass output during November exceeded $30,000,000. This was slightly below October but was well ahead of the same month in both 1938 and 1937. On an eleven month basis 1939's production totalled $293,000,000 as compared to $224,000,000 and $334,000,000 in the comparable periods of 1938 and 1937 respectively.

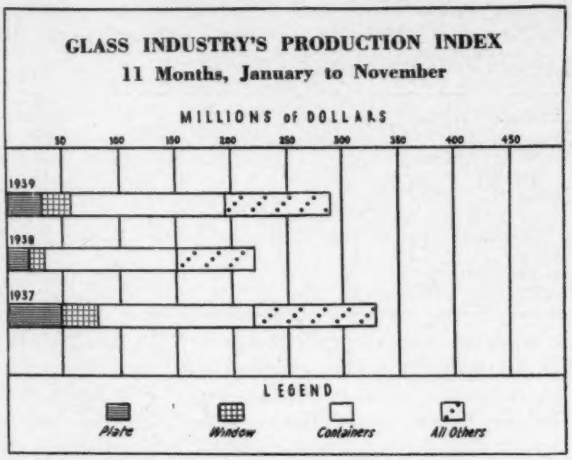


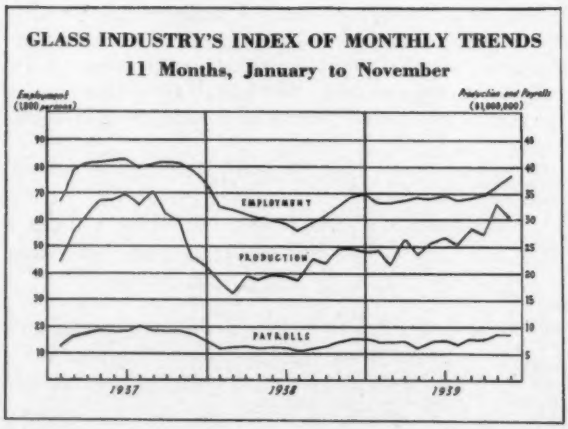
Plate Glass output during November totaled 15,812,000 square feet according to the Plate Glass Manufacturers of America. This represented a 14 per cent decrease from the previous month but a 23 per cent increase over the same month last year. It was expected that November's volume would be much higher bringing the year's total close to the 1937 record, but the extended strike in Chrysler automobile plants reduced demand for automobile glass and made the expected development impossible. Eleven month's figures of plate glass activity indicate that 1939 is running almost 70 per cent ahead of 1938 but is 33 per cent below the 1937 level.

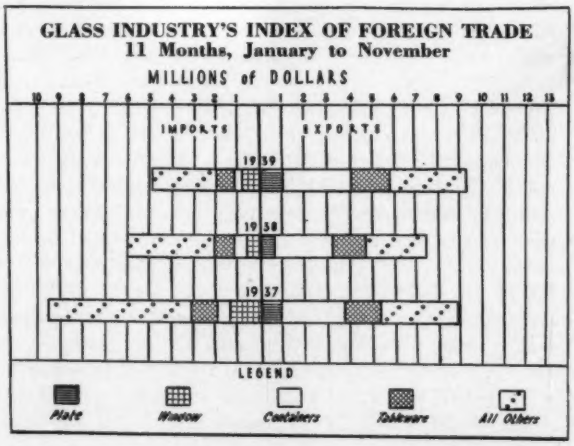
Window Glass production during November amounted to 1,143,000 boxes according to the monthly report of the Window Glass Manufacturers Association. This was only a two per cent increase over the previous month but exceeded all monthly totals since October 1937. November's activity was 29 per cent ahead of the same month last year pushing the eleven month's volume 70 per cent ahead of 1938 and within 24 per cent of 1937.

Glass Container production during November totaled 4,300,000 gross according to the Glass Container Association. This was a decline from the previous month, following the usual seasonal pattern, but represented a 16 per cent increase over November 1938 and 39 per cent over the 1937 figure. During the eleven months of 1939 container output exceeded 47,000,000 gross which was 32 per cent greater than 1938's comparable period and within 3 per cent of 1937 (the industry's record year). Shipments during November dropped more sharply than production bringing stocks on hand up to 8,373,000 gross.

Miscellaneous Glass Products manufactured during November were valued at almost $10,000,000 according to reliable estimates. This about equalled October's volume but was 20 per cent above the 1938 level and almost 30 per cent greater than the comparable 1937 figure. Although illuminating ware production declined 10 per cent from the previous month it continued above 30 per cent above 1938. Tableware plants operated at near capacity rates, exceeding, in many cases, October records. Announcement was made that manufacturing of glass prisms (formerly imported) was proceeding satisfactorily in an American plant which is attempting to increase our idependence as a glass producer.)

Employment and Payrolls: According to the United States Bureau of Labor Statistics approximately 77,000 wage earners were employed in the glass industry dur-





ing November. On the basis of these statistics it appears that 3,000 additional employees were hired during November bringing the employment totals 12 per cent ahead of the same month last year and within 2 per cent of November 1937.

The glass industry had the largest November payroll in history equalling October's level of $8,900,000. During the first eleven months of 1939 glass companies paid out $82,000,000 in wages as compared to $69,000,000 during the 1938 period and $96,000,000 in 1937.

The maintenance of November payrolls at October's figure despite increases in employment indicates that overtime work was cut down by the hiring of additional workers. This adjustment was expected because of the unbalanced ratio of payrolls to employment which existed during October when the monthly index of payrolls jumped to 120.6 from 105.0 as compared to employment's increase to 106.2 from 100.9.

Foreign Trade: United States foreign trade in glass products during November were valued at $1,700,000—a slight decline from October's total. Imports increased over the preceding month as exports dropped while a reverse pattern is evident when comparisons are made with last year.

Outward shipments of glass during November totalled $1,072,000 which was 21 per cent less than in October but exceeded last November's figures by 48 per cent. Although all lines were sold in decreasing amounts when compared with October, increases in all types were recorded as compared to the same month last year. Window glass accounted for the largest percentage gain while containers, tableware and miscellaneous glassware exports were well ahead on a volume basis. Eleven month totals show that 1939 exports are running 25 per cent ahead of 1938.

November imports of glass rebounded from the low levels of recent months to $627,000—a 50 per cent increase over October and within 14 per cent of last November. Purchases of foreign made tableware declined 37 per cent but with that exception all types of glass were imported in larger amounts as compared to October. On a year to year basis declines were noted in all lines with the exception of miscellaneous glassware which accounted for an 8 per cent increase. During the first eleven months of 1939 imports were valued at $4,851,000 which was 19 per cent less than 1938's comparable period.

FOREIGN TRADE OPPORTUNITIES

Below is a list of recent inquiries received at the Specialties Division, Bureau of Foreign and Domestic Commerce. Those interested should write immediately to H. B. McCoy, chief of the Division, or to any of the Bureau's District or Cooperative offices, specifying the reference numbers of any inquiries they wish to contact.

Reference Number	*Commodity*	*City and Country*	*Purchase or Agency*
5057	Heat-proof cooking ware	Johannesburg, S. Africa	Agency
4983	Window glass	Buenos Aires	Agency
5013	Window glass	Lima, Peru	Agency
5058	Window glass	Johannesburg, S. Africa	Agency
5065	Gift glassware	Vera Cruz, Mexico	Agency
5015	Household glassware	Managua, Nicaragua	Agency
4978	Window and shatter-proof glass; glassware	Mexico City	Both
5118	Dark green beer bottles	Alexandria, Egypt	Both
5136	Bottles, jars for perfumes and lotions	Singapore	Both
5206	Pharmaceutical perfume bottles	Habana, Cuba	Agency
5207	Plate glass (crystal, safety and decorative)	Alexandria, Egypt	Purchase
5138	Glass lamp chimneys	Georgetown, Br. Guiana	Agency
5203	Glassware	Rio de Janeiro	Agency
5162	Glassware	Guayaquil, Ecuador	Agency
5507	Glass knobs for reflectors	Germiston, South Africa	Purchase
5477	Plate and window glass	Recife, Brazil	Purchase
5481	Window, figured and flashed white opal glass	Toronto, Canada	Purchase
5452	Glassware	Sidney, Australia	Agency
5510	Glassware	Singapore	Both
5503	Glassware	Dublin, Eire	Purchase
5487	Household and novelty ware	San Jose, Costa Rica	Purchase
5480	Glassware	Bogota, Colombia	Agency
5488	Glassware	Capetown, South Africa	Purchase
5204	Glass jars and sealers	Winnipeg, Canada	Agency
4815	Window glass	Blumenau, Brazil	Agency
4874	Window glass	Lima, Peru	Agency
4875	Window glass	Lima, Peru	Agency

UNITED STATES FOREIGN TRADE IN GLASS
(VALUES IN THOUSANDS OF DOLLARS)

	1939			*1938*		*Percentage Change*		
	October	*November*	*Eleven Months*	*November*	*Eleven Months*	*Oct.-Nov.*	*Nov.-Nov.*	*Eleven Months*
EXPORTS								
Plate	197	122	1005	68	698	— 38	+ 79	+44
Window	10	10	50	4	33	....	+150	+52
Containers	427	348	3104	227	2604	— 19	+ 54	+19
Tableware	211	198	1759	128	1425	— 6	+ 55	+23
Illuminating Ware	57	42	411	37	371	— 26	+ 14	+11
All Other	456	352	3068	261	2377	— 23	+ 35	+29
Total	1358	1072	9397	724	7508	— 21	+ 48	+25
IMPORTS								
Plate	9	12	70	17	105	+ 33	— 29	—33
Window	43	63	766	75	704	+ 47	— 16	+ 9
Containers	25	30	310	66	527	+ 30	— 55	—41
Tableware	100	63	812	100	931	— 37	— 37	—13
Illuminating Ware	6	23	361	52	556	+283	— 56	—35
All Other	174	436	2532	403	3180	+151	+ 8	—20
Total	418	627	4851	713	6003	+ 50	— 14	—19

PORTLAND CEMENT IN GLASS BATCH BRIQUETS

By R. L. SHUTE and A. E. BADGER
Department of Ceramic Engineering, University of Illinois

The use of briquetted glass batch has the pronounced advantages of preventing batch segregation and promoting homogeneity of the metal as well as of decreasing carry-over of dust into the checkers. Disadvantages are the higher batch cost due to the addition of a binding agent and the expense of a briquetting machine.

The usual method of forming briquets from glass batch is by the addition of water glass (sodium silicate solution) to the batch with subsequent pressing of the mixture in a briquetting machine. Another method of binding utilizes the lime present in the batch, which acts as a mortar after the addition of water.

Ordinary Portland cement has not been used commercially as a binder for glass batch briquets. It has the merits of being fairly low in cost and of furnishing alumina to the glass composition. The presence of iron oxide in all Portland cement compositions provides certain restrictions to its use.

Some preliminary experiments have been made to determine the minimum amount of Portland cement necessary to form a reasonably strong briquet. For example, the following simple glass batch was mixed with enough water to form a crumbly mixture and then placed under 2,000 lb. pressure.

Glass Batch Used

Sand	1000
Soda ash	388
Limestone	169
Portland cement	114

Briquets of various dimensions were formed such as one-inch round by three inches long and three inches round by six inches long. These briquets could be handled safely after removal from the press and became hard after standing for several hours, the alkalis in the glass batch acting as accelerators for the setting process.

A normal Portland cement may have the chemical composition, in per cent, of—65 CaO, 2 MgO, 7 Al_2O_3, 3 Fe_2O_3, 22 SiO_2, 1 Alks. Assuming a cement of this composition, the above batch would produce a glass of the composition,

72.00 SiO_2
11.84 CaO
0.16 MgO
0.56 Al_2O_3
0.24 Fe_2O_3
16.00 Alks.

This is a common soda-lime-silica glass, except for the high content of iron. A lower iron glass (about 0.1 per cent iron oxide) would result if a white Portland cement were substituted for the Portland cement used above.

If prices of raw materials are assumed to be $3.00 per ton for sand, $20.00 per ton for soda ash, $9.00 per ton for burned lime, and 65 cents per 100 pounds for Portland cement, the glass would have a raw material cost of 0.45 cent per pound of glass produced.

The conclusions which may be drawn from these preliminary experiments are that Portland cement shows some promise of commercial use in forming glass batch briquets, especially for glass where iron oxide may be present in appreciable amounts, as in high-iron plate glass. The raw material cost is somewhat higher than that of the usual batch but may be offset by advantages resulting from the use of briquetted batch. Additional work on the method of forming the briquets must be performed before any commercial use would be advisable.

• An experimental house designed to trap the sun's heat falling on the roof and store it in the basement for future use is ready for research on the utilization of solar radiation at the Massachusetts Institute of Technology. The purpose of the investigation is to study uses of solar heat, including winter house heating, summer air conditioning, and power generation.

• Chain Belt Company of Milwaukee has been awarded a contract by the Columbia Construction Company, Inc., of Redding, California, to furnish the belt conveyor idlers for the longest belt conveyor system ever installed—9.6 miles long.

"Beautiful but Bad" has been suggested as a proper caption for this remarkable photograph. The flowers look like living marine plants growing under water. But don't be fooled! It is only a piece of glass removed from the bottom of a glass tank. The "flowers" are suspected of being caused by iron.

INVENTIONS AND INVENTORS

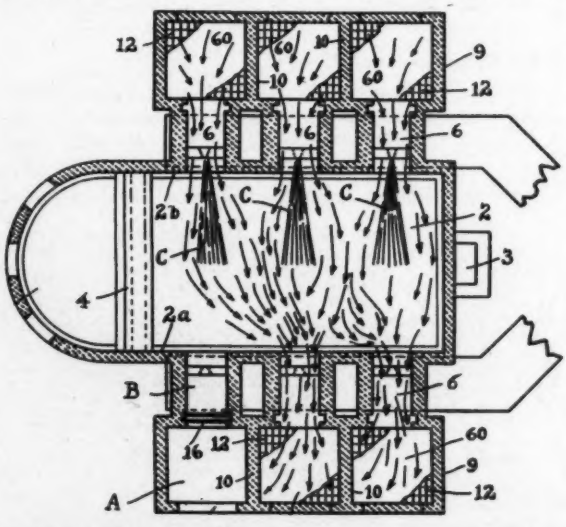
Summary of United States Patents of Interest to the Glass Industry Issued During November.*

Furnaces

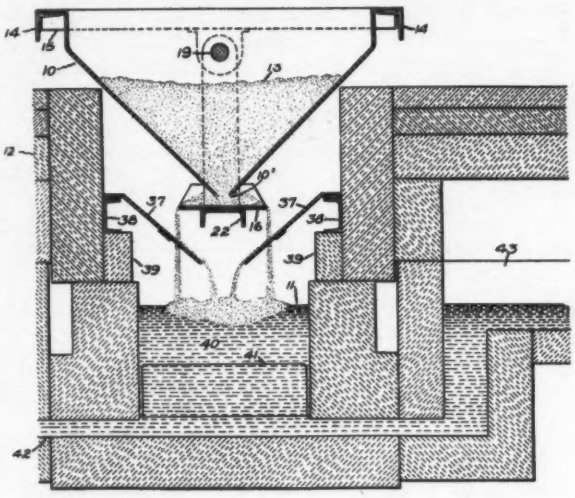
Samuel A. Forter has patented an improvement in side-fired regenerative glass tanks which permits a single regenerator to be repaired or rebuilt without interrupting operation. The accompanying illustration from this patent, 2,179,848, shows how the products of combustion are diverted from port B and into the remaining regenerators on a given side of the furnace. This is made possible by the application of a shut-off damper (16) at the back of port B and another damper which stops off the connecting flue between the given regenerator chamber and the stack. The invention applies particularly to oil-fired furnaces. It is claimed that the suspension of operation of a given port as an outlet to the regenerator does not interrupt its service as a burner port. The patent was assigned to Forter-Teichmann Co.

Patent 2,178,418 to Carl L. Brown and Chas. W. Craig (General Electric Co.) is a feeder designed to feed batch material gradually end evenly over a large area in an electrically-heated melting tank. The feeder is not adapted for other fuels. The hopper (10) extends the full width of the tank and the material is fed when the bottom plate (16) is swung back and forth across the opening. The batch falls upon steel slats (37) to give a wider spreading action.

Another patent in the group which Thomas F. Pearson of Pontefract, England has assigned to the Crown Cork & Seal Co., is 2,180,767, which covers a skimming device for glass tanks. Its purpose is to remove the "relatively cold skin" which is said to accumulate at the surface of the glass in the forehearth, due to exposure to the atmosphere. The principle elements are shown by the accompanying Fig. 2 from the Pearson patent. A gathering mold (not shown) is adapted to pick up charges at 55. The skimmer 19 with lower edge 54 moves from the dotted position over the bridge 13, to a position back of the bridge, so as to pull the cold glass from the front of the furnace and replace it with glass which flows under the bridge. The skimmer then withdraws from the bath and completes its orbital path to the starting position.



2,179,848: Forter. Furnace construction designed to allow repairing or rebuilding of one checker chamber without shutting down the entire furnace.



2,178,418: Brown and Craig. Batch feeder for use with electrically-heated glass-melting tank.

John H. Thomas patented (2,181,030, to Owens-Illinois) a method of melting glass in an electric furnace wherein the heat is supplied through a coiled induction element (of platinum, etc.) over which the batch materials flow.

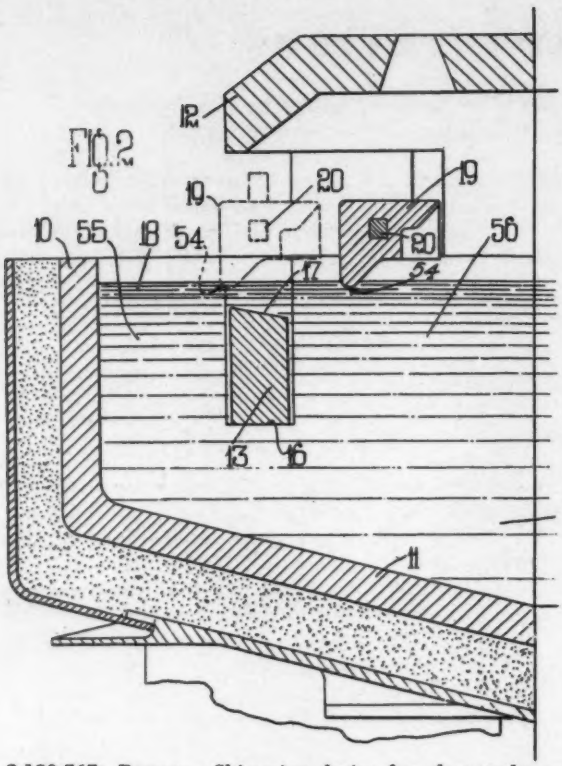
Henry H. Blau and Kenneth K. Knaell assigned to the Carborundum Co., their patent 2,178,134 covering means of repairing the tank portion of a furnace while it is in operation. Cast refractories, heavy enough to sink in the glass are first heated and then deposited through the molten glass in an over-lapping manner to form a covering layer on a wall of the tank. This patent presumably is a by-product of the cooperation between the Carborundum Co. and the MacBeth Evans Glass Co., which was a factor in the development and introduction of cast refractories by the former.

Feeding, Forming and Shaping

Randolph H. Barnard of Toledo, patented a method and machine for forming glass building blocks,(2,179,317). The machine utilizes two adjacent streams of molten glass from which charges are severed to form the two halves of the block. The molds, traveling in pairs, are aligned with gravity-actuated pressing plungers which form the half-sections. These are inverted and passed over a pool of a liquefied cementing medium, and the adjacent molds of each traveling pair are then brought together to press the coated edges of the half-sections together to bond them.

Thomas F. Pearson of Pontefract, England, assigned to Crown Cork & Seal Co., his patent 2,180,766 for an

*Included also are several patents issued during October, too late for inclusion in our December issue.



2,180,767: Pearson. Skimming device for glass tanks or furnaces.

adjustable cam track for use on a glassware forming machine.

Albert B. Knight of Fairmont, W. Va., patented (2,177,807) a cracking-off machine in which horizontal rollers support the glass article while a thin flame is for a time directed against it, patentability in part being due to novel means of controlling movement of the ware.

For the production of coiled glass tubing, Theodor Pfaff of Weisswasser O.-L., Germany, patented (2,177,743, to General Electric) a process which comprises gathering a parison of glass between a blowpipe and gathering iron, drawing a length of tubing, and bending it into coiled shape while still plastic.

Miscellaneous Processes

Patent 2,180,992, assigned by George J. Meyers, Jr., to General Electric, is concerned with a method of fastening an aluminum reflector to glass globes of street-lighting luminaires. The reflector is expanded by heating slightly, for example to 88 deg. C., and is then crimped or spun to the globe while the assemblage is being turned.

In tempering or case-hardening glass sheets, George E. Howard of Butler, Penna., proposes to connect electrodes for alternating current to the edges of the sheet to be used in maintaining the temperature in the core of the sheet while its skin is being cooled. An objective is the removal of uneven strain. An illustration from this patent (2,178,520, assigned to Hartford-Empire Co.) appears herewith.

L. W. Goddu and C. H. Caldwell assigned to American Optical Co., their improvement (2,179,088) in lens polishing apparatus.

In patent 2,180,737, Henry W. Hess of Toledo covers in a single claim, a method of surface-chilling for shaped glass articles, such as milk bottles, to increase their strength. The inside of the ware is subjected to a blast while still in the mold, which is for the purpose of equalizing the cooling effect produced by the mold on the outside surface. A further feature is the removal of the ware from the blow molds, possibly before they can support their own weight, by an apparatus which grasps their neck ring. They are then chilled by a cooling blast applied both inside and outside the bottle.

Patent 2,181,810, assigned by Chas. E. Hawk of Muncie to Owens-Illinois, provides an apparatus for trimming off the excess bonding material after two sections of a glass block have been united.

Plates and Sheets

Patents 2,178,504 and 2,179,740, assigned to Pilkington Bros., Ltd., of Liverpool by F. B. Waldron and J. H. Griffin, represent improvements in apparatus for grinding and polishing the under side of a moving glass sheet.

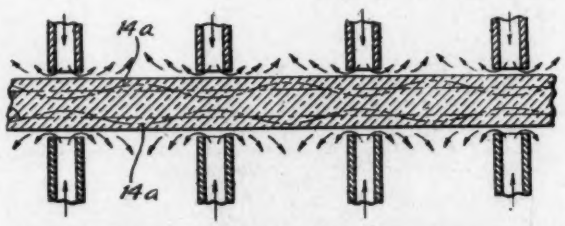
Edwin H. Land patented (2,180,113 to Polaroid Corp.) a translucent screen comprising a sheet of set transparent plastic, having distributed within it numerous transparent particles of such shape that the boundary surfaces between plastic and particles are non-parallel, the particles having one dimension slightly exceeding the wave lengths of visible light, the indices of refraction of particles and plastic differing only slightly for light vibrating in any direction, and with a high ratio of refracted to reflected light at each particle-plastic surface.

An important laminated glass patent, applied for on May 6, 1933, was granted to Frederic L. Bishop of American Window Glass Co. Claim 1 provides for heating a solution of a plastic strengthening material, such as acrylic acid ester, substantially to the the boiling point of its solvent, forming a layer of the solution on a glass sheet, drying the layer and then rigidly uniting this coated sheet to a second sheet with the strengthening layer between them. Novelty apparently resides largely in the heating step, which aids in bubble elimination and gives other benefits. This is patent 2,180,625.

New Products and Uses

Thomas W. Rolph of Newark obtained two patents on light transmitting building blocks. These were 2,179,862 and 2,179,863, assigned to the Holophane Co., Inc. Claim 1 of the latter patent descibes a hollow brick with refracting prisms in at least one side wall so constructed

(*Continued on page* 36)



2,178,520: Howard. Alternating current is passed laterally through the glass sheet to heat the center portion and reduce the unevenness in temperature caused by the cooling nozzles. Thus an isothermal line tends to be straight instead of wavy.

EQUIPMENT AND SUPPLIES

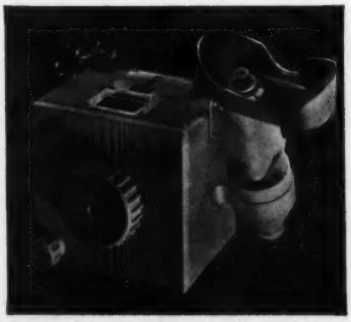
L & N POTENTIOMETER-TYPE OPTICAL PYROMETER

A NEW optical pyrometer of the potentiometer type has recently been placed on the market by Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa. It is said that this is the first optical pyrometer to use the potentiometer method. The instrument is calibrated directly in temperature degrees, rather than milliamperes, and is therefore used more conveniently and with greater accuracy than former designs.

To measure the temperature of a glowing object with the new device, the operator looks through the telescope. Within the telescope is a glowing filament and the filament is observed to be lighter or darker than its background. The brightness is adjusted by turning a knob on the control box until the filament disappears, matching and merging with the object on which he is sighting. The potentiometer is then balanced by a slight turn of a second smaller knob, after which the temperature is read directly in degrees from the instrument scale. Standard ranges are from 1,400 to 5,200 deg. F.

The filament switch is mounted on the telescope, so that it closes automatically when the operator picks it up, the filament coming up to temperature while the telescope is being brought to the eye. When the telescope is released the switch springs open, eliminating needless drain on the battery. It is stated that only a few seconds are required to sight the telescope, adjust the filament brightness, balance the potentiometer and read the temperature scale. After each reading the telescope may be placed in a holder on the side of the potentiometer case, thus leaving the operator's hands free to make notations.

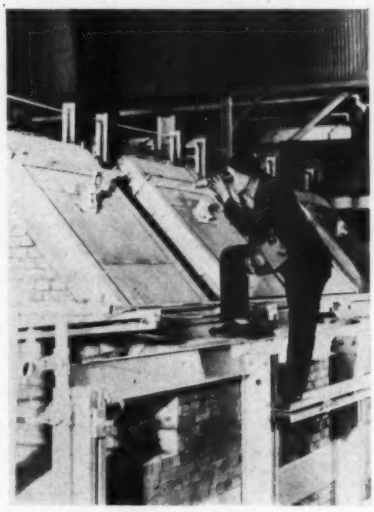
In the telescope of the new pyrometer the image appears right side up and the eye-shield is of flexible material to fit any operator's face comfortably. The housings are of dust-tight , light-weight, alloy castings. Complete details of the new device are illustrated and described in Catalog N-33D.



Potentiometer-Type optical Pyrometer.

FERGUSON TO BUILD NEW CORNING LABORATORY

TO THE H. K. Ferguson Company, Cleveland, Ohio, has been awarded the contract for the design and construction of a 4-story and basement Laboratory and pilot plant, 82 feet by 114 feet, at the Corning Glass Works, Corning, N. Y. The building will be of steel and concrete construction, with brick exterior, and will conform in general to the design of existing buildings. Glass block will be used in place of conventional windows, and for the inside partitions.



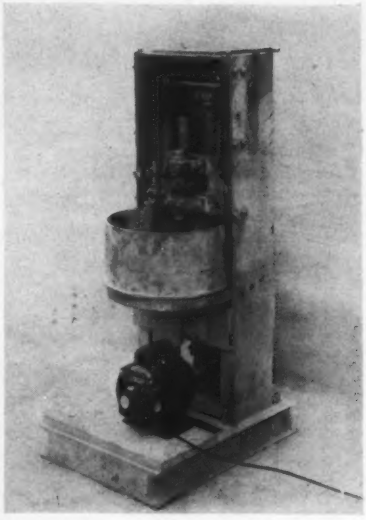
Direct temperature reading is greatly simplified by the new Leeds & Northrup instrument.

CATALOGS RECEIVED

Audubon Wire Cloth Corp., Philadelphia. Catalog 50-14 "Audubon Metalwove Belts." A 44 page catalog describing and illustrating numerous types of conveyor and processing belts which can be obtained in any ductile metal most resistant to various operating conditions. It contains photographic illustrations of various belts, enegineering diagrams, specifications and a questionnaire form for individual problems.

The Mullite Refractories Co., Shelton, Conn., has just issued a new 50 page catalog describing its line of "Shamva Mullite" super refractories. The contents are devoted to installations and data. Also described in the catalog are air and heat setting cements. A copy of the new catalog can be obtained by writing to the company.

Cutler-Hammer, Inc., Milwaukee. "Dust the Destroyer" is the title of a new booklet designed to inform users of motor control about the advantages of Cutler-Hammer vertical contacts. It is colorfully illustrated and contains essential data on this subject.



The new PCA Lancaster mixer.

NEW LANCASTER MIXER

Lancaster Iron Works, Inc., Lancaster, Pa., has just announced a new laboratory mixer. Known as the P C A Model, this mixer embodies the features of uniform mixing intensity and control, as is provided in the larger "Lancaster" mixing equipment. The unit is very compact with an overall height of 39½", a width of 15½" and a depth of 21". It weighs approximately 325 pounds. The mixing pan is 12" inside diameter by 5" deep and is removable. The minimum batch is approximately one quart and ranges upwards to one gallon. The pan operates in a clockwise direction at a speed of 17 r.p.m., while the plow operates counter-clockwise at 67 r.p.m. The unit is operated through gear reduction and is furnished complete with a ¼ h.p., 110 volt, 60 cycle, S. P., AC motor.

TO REPRESENT MULLITE

The Mullite Refractories Company announces the appointment of Mr. F. M. Ruggles as mid-west sales representative. He will cover the states of Illinois, Wisconsin and Missouri from headquarters located in Chicago. Mr. Ruggles is a graduate ceramic engineer with a refractory background.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	43.00	46.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_710H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027 -.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054 - .0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.0865-.0875	.0925
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00-31.00	....
In bags	ton	31.60-32.60	42.00-45.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.08	....
In 5 Ton lots	lb.	....	.08½
Less than 5 Tons	lb.	....	.09
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	8.50	8.50
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.00-14.00	....
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00-20.00	25.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls. 95% and 97%	Per 100 lb.	....	2.50-2.90
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.029	.03½
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	No supplies available.	
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05¾-.06	.06¼-.06½
Tin Oxide (SnO_2) in bbls.	lb.	....	.52
Titanium Oxide (ceramic grade)			
In bags	lb.	.12	.12¼-.12¾
In barrels	lb.	.12¼	.12½-.13
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls.	lb.	.08¼	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	.95
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.25
Chromite (99% through 200 mesh)	ton	35.50	40.00
Chromite ore (air floated)	ton	55.00	58.00-73.00
Cobalt oxide (Co_2O_3)			
In bbls. 350 lbs. or more,	lb.	....	1.84
Less than 350 lbs.,	lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.165
Black (CuO)	lb.	....	.18-.19
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425-.09
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls.	lb.	....	.135
Manganese, Black Oxide			
In Paper bags	ton	62.50	65.50
In Burlap bags	ton	64.25	67.25
In Casks	ton	66.50	69.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09½-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.18-.22
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08⅛	.08⅛-.08½
Sodium selenite (Na_2SeO_3)	lb.	....	1.50-1.65.
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.75-1.80
Yellow	lb.	....	1.75-1.80
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.65-2.75
Yellow orange	lb.	....	1.75-1.80

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.04
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	....	.03½
Rouge, Red	lb.	....	.16
Black	lb.	....	.18

DR. KREIDL AT PENN STATE

Dr. Norbert Kreidl has just been appointed Assistant Professor of Glass Technology in the Department of Ceramics at The Pennsylvania State College. The appointment will take effect on February 1. Dr. Kreidl was born in Vienna, Austria. He studied physics and chemistry at the Universities of Vienna, and Bern, Switzerland. He obtained his Ph.D. from the University of Vienna. After having graduated he carried out research work at the Kaiser Wilhelm Institut für Silikatforschung in Berlin. Later he was in a position to continue his researches in the field of special glasses in Czechoslovakia. During his stay there he remained in close contact with the Kaiser Wilhelm Institut in Berlin but also collaborated with the governmental Institute for Glass Technology in Königsgraetz, Czechoslovakia, and with Glashuttenwerke vorm. J. Schreiber and Neffen. For more than a year now he has been carrying out special research work connected with the introduction of Bohemian glasses to this country, including large-scale experimentation on various types of white and tinted opal glasses, in which work he has been assisted by the Dunkirk Glass Works, Dunkirk, New York.

Dr. Kreidl will work in collaboration with Professor Woldemar Weyl on a research project sponsored by the Monsanto Chemical Company concerning the use of phosphates in glasses and other ceramic products.

DR. MODIGLIANI VISITS U. S. A.

Dr. Piero Modigliani, well known glass maker of the firm of Balzaretti Modigliani, with offices in Rome, Italy, is visiting this country with his wife and family. Dr. Modigliani arrived early in December on the *S.S. Vulcania* and has been making his headquarters in New York City. Early in January he plans to make a short business trip through the middle west before returning to Italy.

E. D. Griffin, vice president of the Pittsburgh Plate Glass Company has been transferred from Milwaukee to the company's general office at Pittsburgh. This move is part of a plan to co-ordinate the company's paint and glass executive offices at Pittsburgh.

Raymond Stevens, vice-president of Arthur D. Little, Inc., Cambridge, Mass., has been appointed director of a nationwide survey, the object of which will be to present an objective study of industrial research as a national resource, as a means of aiding its further development and utilization. The survey is a project of the National Research Council, and will be financed by funds made available by the National Resources Board. An Advisory Committee with a large personnel will include among others E. R. Weidlein, and L. W. Bass, of Mellon Institute; M. H. Eisenhart of Bausch & Lomb; George R. Harrison, M. I. T.; and Frank C. Whitmore, Pennsylvania State College.

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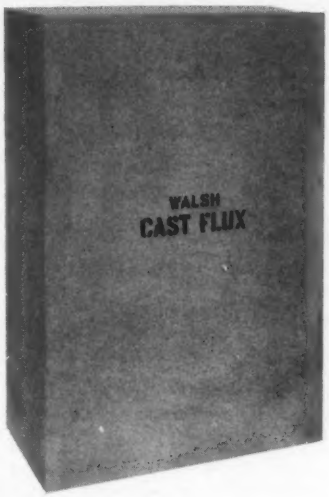

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STAINING GLASSES WITH SILVER

(*Continued from page* 18)

shown was originally in the interior of the glass. Figure 9 shows a pattern observed after staining on the original surface of a bottle. These surface streaks, which usually appear only on the outside surface of the bottle, are often evidence of very shallow surface cords, which may also be visible as uneven ridges or brush marks, and they may not extend far enough into the glass to be visible in the sawed sections. These shallow surface cords can also be made to stand out either by acid etching or by autoclaving. Not all of the exterior streaks observed after staining are of this type, however, and if an interior dark or light streak happens to outcrop on the surface of the bottle, it will be seen both in the sawed surface and in the original surface.

In these cases the intensity of color developed by silver staining seems to depend mainly upon the composition of the glass with respect to iron and arsenic. It is probable that, since in flint bottle glass arsenic is present in considerably larger amounts than iron (0.1 per cent arsenic trioxide and arsenic pentoxide compared to 0.05 per cent ferric oxide) the iron plays a small part in the development of the color, and is largely in the oxidized state of ferric oxide. Consequently whatever streaks are observed are due to fluctuations in arsenic trioxide or rather to fluctuations in the ratio between arsenic trioxide and pentoxide. So in the case of the lighter streaks we may assume that we have to deal with an increase in arsenic pentoxide at the expense of the trioxide in that part of the glass oxidized at the surface of the feeder.

Summary and Conclusions

The silver staining method is based on the fact that the development of the yellow color due to silver migrating into the glass is greatly influenced by the minor constituents in the glass such as ferrous oxide, iron sulphide, arsenic trioxide and the like, but it is also influenced by the alkali acid ratio in the glass.

The present method therefore may offer a tool to differentiate between inhomogeneities which are caused by different reducing or oxidizing conditions in manufacture or which are accompanied by the aforesaid changes in composition, and between such inhomogeneities where other changes in composition are predominant, such as may be caused by segregation or batch changes, silica scum, incomplete melting, refractory drops and the like.

In those cases where the silver staining develops inhomogeneities as a pattern darker or lighter than the evenly stained background, the present method offers a means to visualize the actual habitus of the inhomogeneity.

Preliminary experiments with flint glass bottles lead to the following conclusions:

Inhomogeneities developed by staining indicate primarily the reducing or oxidizing nature of the atmospheres to which the glass has been exposed on its way through the tank. Since the surface layer in the feeder may be identified in some cases by a light streak after staining, the cordy structure in the bottle may be oriented, and one may determine then whether a serious cord is coming from a surface layer or near it in the feeder. This might be of value if the distribution of cord in a bottle could be changed.

The origin of the darker inhomogeneities is not so precisely known as that of the lighter ones. However, this reduced glass may be corrosive and may attack refractory materials if it comes in contact with them, giving rise to aluminous cords. It may also be a source of seed. It is possible that the method may have some application to this peculiar kind of attack on refractory materials, as well as to the production of seed in glass tanks. These applications can only be made by studying plant operations in some detail. Finally, cord caused by a change in pull on the tank may stain differentially, and the dead glass pulled in when the channel changes appears, in some cases, to stain darker than the glass coming through the channel.

Acknowledgment

The authors wish to express their gratitude to the Dunkirk Glass Works and to Mr. Frederik Binder of Dunkirk Glass Works for having made available to Dr. Norbert Kreidl the facilities for carrping out the large scale experiments mentioned in this paper and for the invaluable assistance given to them during these experiments.

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BOB WARREN HOST TO NIMRODS

Whetstone Run Cottage was again the scene of much activity last month when glass men from all over the country assembled at Brockway, Pennsylvania, for the annual deer hunt as guests of Robert L. Warren, President of Brockway Glass Company. The hunters this year lacked the prowess of former seasons—or perhaps their hands were not quite as steady—for the camp failed to make its quota by one. Roy Blunt and Preston Levis gave Dr. Ghering a demonstration of some new types of bottle fractures that have not been covered by the researches of the Butler Laboratories, which only goes to show glass men cannot leave their business behind them even when tramping the Pennsylvania woods. It was a grand hunt, and a superlatively good time was had by all.

The occasion preceded by a few days a distribution of Christmas turkeys which Mr. Warren gave to every employee of the Brockway Glass Co. Nearly three hundred families have at least one member working at the container factor, and each worker received a turkey. The total amounted to just a little under two tons of the favorite Christmas meat.

Automobile production last November declined 6.2 per cent below November of 1938, according to a report by the Automobile Manufacturers Association. Sales for the eleven month period, however, registered a gain of 45 per cent over the previous year. All units sold the past year totalled 3,259,078.

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INVENTIONS AND INVENTORS

(*Continued from page* 30)

as to receive downwardly slanting light, and refract it so that the dominant light rays are emitted from the opposite face in an upwardly oblique direction.

Two patents involved the use of glass wool. One was 2,181,074, assigned by Roy J. Scott to Alfol Insulation Co., Inc. This is a heat-insulating panel for high temperature industrial equipment. A typical form has a metal backing, separated by glass wool or other insulation from a front of reticulated or expanded metal, particular attention being paid to elimination of heavy metallic connections which could transmit heat through the panel. A patent to Games Slayter, assigned to Owens-Corning Fiberglas Corp. (2,178,614) concerns the use of an air filter containing fibers coated with oil that contains a zinc soap to extend the dust catching surfaces.

Patent 2,181,240 granted to Herman K. Kimble concerns a method of producing a double-walled container.

Window constructions were covered by patents 2,181,-763 to Hans Mockli, 2,181,745 to H. R. Seibold, 2,181,-385 to LeRoy B. Taylor, and 2,179,668 to Russell B. Nelson.

BIG YEAR FOR BOTTLED BEER

The largest volume of beer in bottles in the history of United States brewing is predicted for 1939 on the basis of a report published by the Glass Container Association. The report is based on beer packaging data gathered in July from 552 of the 581 brewers in operation, and shows that 91.5 per cent of all packaged beer was sent to market that month in glass bottles. Packaged beer now almost equals draft beer volume.

Since July is the peak month of canned rather than of bottled beer sales, it is estimated on the basis of past sales records that bottled beer will average 93.0 per cent of packaged beer for the 1939 twelve-month period. This will mean that a volume of nearly 24,000,000 barrels of beer is being marketed in bottles this year, more than in any other year before Prohibition or since Repeal.

The 93.0 per cent figure for bottled beer in 1939 compares with 92.5 per cent in 1938 and 92.0 per cent in 1937, the latter percentage being based on the Bureau of Manufacturers' record of beer can production in that year.

Analysis of beer container use in July shows that the following percentages of packaged beer sales went into the various containers:

	Per Cent
Steinies	27.5
Exports	52.7
12oz. Cans	7.9
32-oz. Cans	.6
Quart Bottles	6.3
Half-Gallon Bottles	3.3
Miscellaneous (glass)	1.7

• War is not being allowed to interfere with the historic Leipsig Fair, which has been held without interruption for more than 700 years. In fact, a larger representation and attendance than ever is expected this year, and a new building has been added to the 42 already in use. The fair will be held March 3 to 10.

DECENNIAL CENSUS UNDER WAY

Facts and figures on the operations during 1939 of the glass industry as a whole are now being assembled on a nationwide scale by the U. S. Bureau of the Census as part of the sixteenth Decennial Census.

Especially designed to assemble salient facts on this industry, the special glass industry schedule will enumerate the number of people employed in each plant in 1939, the kind of work they performed and their sex, beside ascertaining the total salaries and wages paid out during the year. Other questions will record the cost of materials, fuel, electric energy, and important expenditures for plant and equipment. An inventory of power equipment by number of units, horsepower or kilowatt rating will be obtained along with an inventory of finished products, materials, supplies, fuel and work in process at the beginning and end of the year. The inventory reports will develop comparative data essential to a measurement of the industry.

The products report, asked for by the last inquiry on the schedule, gathers figures not only in dollars but by dozens, grosses, number of pieces or square footage (whatever measure is common to each product) of principal and secondary products turned out by each plant.

The products inquiry asks specific figures on window glass, clear, obscured or wire; glassware, machine and hand made; lighting glassware; and or glass containers for food products, beverages and medicinal and toilet preparations. The 1937 Census of Manufactures report shows that $100,938,000 of flat glass, $86,441,000 of glassware other than containers, and $160,646,000 of glass containers was manufactured that year. The production of medicinal and toilet preparations containers, amounting to $36,156,000 took first rank while the output of window glass ranked second with a value of $31,389,000 and liquor glassware production $30,462,000 third.

Mirrors and other glass products made of purchased glass which as far back as 1935 showed a $3,000,000 rise above the 1929 figures, are being covered under a separate schedule. In 1937 this branch of the glass industry had a total turnover of $88,000,000 which was $23,000,000 above the 1929 production reported to the Bureau.

Basic figures on the glass industry will be published in late summer or early fall, to be followed as rapidly as possible by more detailed reports.

Census enumerators will deliver schedules to the reporting plant, in person, and will call for them after they have been filled out.

The same law which requires reporting to the Census Bureau protects those giving the answers against disclosure of individual returns, or their use for taxation, regulation or investigation.

• An official of Libbey-Owens-Ford Company has recently estimated that glass can be had in more than 65,000 color combinations.

A CORRECTION

In the article "Improving the Strength of Glass Containers Through Design," published in our December issue, there appeared on page 444 the statement: "Theoretically, the cylinder most economical of material is one whose weight approximately equals the diameter." The word *weight* should read *height.*

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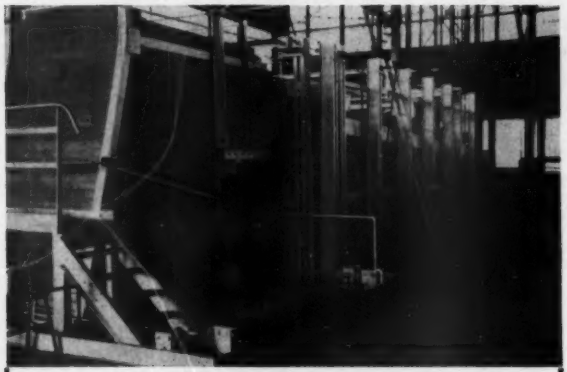

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